

# **Biosphere Reserves**

## **Compilation 5, October 1990**

# **Réserves de la biosphère**

## **Compilation 5, octobre 1990**

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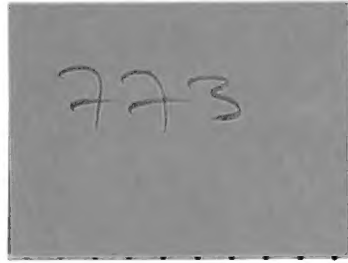
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de la conservation de la nature  
In collaboration with IUCN's Commission on National Parks and Protected Areas  
(CNPPA)  
En collaboration avec la Commission des parcs nationaux et des aires protégées  
de l'UICN (CPNAP)

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## INTRODUCTION

In 1986, Unesco and the IUCN Conservation Monitoring Centre collaborated in the preparation and publication of a fully revised and updated directory of biosphere reserves (MAB Information System: Biosphere Reserves, Compilation 4). Since then 33 new sites have been approved by the MAB Bureau, and there have been significant modifications to a further seven sites. Unesco, IUCN and the World Conservation Monitoring Centre have therefore collaborated in the production of a supplement to the previous directory, which is the compilation presented here.

As with the previous compilation, this directory represents a pooling of the experience and information of the organizations involved in its production, and is intended as a source of information for biosphere reserve managers, MAB National Committees, and scientists working in MAB. These persons and institutions are invited to use this Compilation (and Compilation 4 to which it is a supplement) to develop the cooperative function of biosphere reserves, to increase the exchange of information between reserves, and hence to build up a truly functioning biosphere reserve network.

In order to help maintain the information managed by the World Conservation Monitoring Centre on behalf of the MAB Programme, biosphere reserve managers or responsible authorities are requested to ensure that copies of all relevant documents are sent to either the MAB Secretariat, or to the World Conservation Monitoring Centre. Corrections to the information in this or the previous Compilation would also be welcomed. Addresses are as follows:

### Division of Ecological Sciences

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### World Conservation Monitoring Centre

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## INTRODUCTION

En 1986, l'Unesco et le Centre de surveillance continue de la conservation de la nature de l'UICN ont coopéré pour préparer et publier une compilation sur les réserves de la biosphère entièrement révisée et mise à jour (système d'information du MAB, réserves de la biosphère, compilation 4). Depuis cette date, 33 nouveaux sites ont été approuvés comme réserves de la biosphère par le Bureau du MAB et 7 autres sites ont fait l'objet de modifications significatives. L'Unesco, l'UICN et le Centre mondial de surveillance continue de la conservation de la nature (CMSC) ont en conséquence coopéré pour éditer un supplément à la compilation précédente, qui est présenté ici.

Comme pour la compilation précédente, l'expérience et les informations des organisations concernées par cette production ont été rassemblées et cette compilation a été conçue comme devant constituer une source d'information pour les gestionnaires de réserves de la biosphère, les Comités nationaux du MAB et les scientifiques qui travaillent dans le cadre du MAB. Ces personnes et ces institutions sont invitées à utiliser la compilation (et la compilation 4 qu'elle complète) pour développer le rôle de coopération des réserves de la biosphère, améliorer l'échange d'informations entre les réserves de la biosphère et bâtir ainsi un réseau de réserves de la biosphère qui fonctionne pleinement.

Afin d'aider à la mise à jour de l'information gérée par le CMSC au nom du programme MAB, les gestionnaires de réserves de la biosphère et les autorités compétentes sont invitées à s'assurer que toute copie des documents pertinents est adressée soit au Secrétariat du MAB soit au CMSC, aux adresses indiquées ci-dessous. Toute modification à cette compilation ou la précédente sera également bienvenue.

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**LIST OF BIOSPHERE RESERVES**  
**LISTE DES RESERVES DE LA BIOSPHERE**

May/mai 1990

	Biogeographic province/ Province bio- géographique	Area/ Super- ficie (ha)	Date of approval Date d'- approbation
<b>ALLEMAGNE, REPUBLIQUE FEDERALE D'</b> Voir paragraphe Germany, Federal Republic of			
<b>ALGERIA/ALGERIE</b>			
Parc national du Tassili	2.18.07	7,200,000	1986
<b>ARGENTINA/ARGENTINE</b>			
Reserva de la Biosfera San Guillermo	8.37.12	981,460	1980
Reserva Natural de Vida Silvestre Laguna Blanca	8.25.07	981,620	1982
Parque Costero del Sur	8.31.11	30,000	1984
Reserva Ecológica de Ñacuñán	8.25.07	11,900	1986
Reserva de la Biosfera de Pozuelos	8.37.12	405,000	1990
<b>AUSTRALIA/AUSTRALIE</b>			
Croajingolong	6.06.06	101,000	1977
Danggali Conservation Park	6.10.07	253,230	1977
Kosciusko National Park	6.06.06	625,525	1977
Macquarie Island Nature Reserve	7.04.09	12,785	1977
Prince Regent River Nature Reserve	6.03.04	633,825	1977
Southwest National Park	6.02.02	403,240	1977
Unnamed Conservation Park of South Australia	6.09.07	2,132,600	1977
Uluru (Ayers Rock-Mount Olga) National Park	6.09.07	132,550	1977
Yathong Nature Reserve	6.13.11	107,241	1977
Fitzgerald River National Park	6.04.06	242,727	1978
Hattah-Kulkyne NP & Murray-Kulkyne Park	6.05.06	49,500	1981
Wilson's Promontory National Park	6.06.06	49,000	1981
<b>AUSTRIA/AUTRICHE</b>			
Gossenköllesee	2.32.12	100	1977
Gurgler Kamm	2.32.12	1,500	1977
Lobau Reserve	2.32.12	1,000	1977
Neusiedler See-Österreichischer Teil	2.12.05	25,000	1977
<b>BIELORUSSIE REPUBLIQUE SOCIALISTE SOVIETIQUE</b> Voir paragraphe Byelorussian Soviet Socialist Republic			
<b>BENIN</b>			
Réserve de la biosphère de la Pendjari	3.04.04	880,000	1986
<b>BOLIVIA/BOLIVIE</b>			
Parque Nacional Pilón-Lajas	8.06.01	100,000	1977
Reserva Nacional de Fauna Ulla Ulla	8.36.12	200,000	1977
Estación Biológica Beni	8.35.12	135,000	1986
<b>BULGARIA/BULGARIE</b>			
Parc national Steneto	2.33.12	2,889	1977
Réserve Alibotouch	2.33.12	1,628	1977
Réserve Bistrichko Branichté	2.33.12	1,177	1977
Réserve Boatine	2.33.12	1,281	1977
Réserve Djendema	2.33.12	1,775	1977
Réserve Doupkata	2.33.12	1,210	1977
Réserve Douпки-Djindjiritza	2.33.12	2,873	1977
Réserve Kamtchia	2.33.12	842	1977
Réserve Koupena	2.33.12	1,084	1977

Réserve Mantaritzza	2.33.12	576	1977
Réserve Maritchini ezera	2.33.12	1,510	1977
Réserve Ouzounboudjak	2.33.12	2,575	1977
Réserve Parangalitza	2.33.12	1,509	1977
Réserve Srébaria	2.11.05	600	1977
Réserve Tchervenata sténa	2.33.12	812	1977
Réserve Tchoupréné	2.33.12	1,440	1977
Réserve Tsaritchina	2.33.12	1,420	1977
<b>BURKINA FASO</b>			
Forêt classée de la mare aux hippopotames	3.04.04	16,300	1986
<b>BYELORUSSIAN SOVIET SOCIALIST REPUBLIC</b>			
Berezinskiy Zapovednik	2.10.05	76,201	1978
<b>CAMEROON, UNITED REPUBLIC OF</b>			
Parc national de Waza	3.04.04	170,000	1979
Parc national de la Benoué	3.04.04	180,000	1981
Réserve forestière et de faune du Dja	3.02.01	500,000	1981
<b>CANADA</b>			
Mont St Hilaire	1.05.05	5,550	1978
Waterton Lakes National Park	1.19.12	52,597	1979
Long Point Biosphere Reserve	1.22.14	27,000	1986
Riding Mountain Biosphere Reserve	1.04.03	297,591	1986
Réserve de la biosphère de Charlevoix	1.04.03	460,000	1988
Niagara Escarpment Biosphere Reserve	1.05.05	207,240	1990
<b>CENTRAL AFRICAN REPUBLIC</b>			
Basse-Lobaye Forest	3.02.01	18,200	1977
Bamingui-Bangoran Conservation Area	3.04.04	1,622,000	1979
<b>CHILE/CHILI</b>			
Parque Nacional Fray Jorge	8.23.06	14,074	1977
Parque Nacional Juan Fernández	5.04.13	9,290	1977
Parque Nacional Torres del Paine	8.37.12	184,414	1978
Parque Nacional Laguna San Rafael	8.11.02	1,742,448	1979
Parque Nacional Lauca	8.36.12	358,312	1981
Reserva de la Biosfera Araucarias	8.22.05	81,000	1983
Reserva de la Biosfera La Campana-Peñuelas	8.23.06	17,095	1984
<b>CHINA/CHINE</b>			
Changbai Mountain Nature Reserve	2.14.05	217,235	1979
Dinghu Nature Reserve	4.06.01	1,200	1979
Wolong Nature Reserve	2.39.12	207,210	1979
Fanjingshan Mountain Biosphere Reserve	2.15.05	41,533	1986
Xilin Gol Natural Steppe Protected Area	2.30.11	1,078,600	1987
Fujian Wuyishan Nature Reserve	2.01.02	56,527	1987
Bogdhad Mountain Biosphere Reserve	2.22.08	217,000	1990
<b>COLOMBIA/COLOMBIE</b>			
Cinturón Andino Cluster Biosphere Reserve	8.33.12	855,000	1979
El Tuparro Nature Reserve	8.27.10	928,125	1979
Sierra Nevada de Santa Marta (inc. Tayrona NP)	8.17.04	731,250	1979
<b>CONGO</b>			
Parc national d'Odzala	3.02.01	110,000	1977
Réserve de la biosphère de Dimonika	3.02.01	62,000	1988
<b>COSTA RICA</b>			
Reserva de la Biosfera de la Amistad	8.16.04	584,592	1982
Cordillera Volcánica Central	8.16.04	144,363	1988

**COTE D'IVOIRE**

Parc national de Taï	3.01.01	330,000	1977
Parc national de la Comoé	3.04.04	1,150,000	1983

**CUBA**

Sierra del Rosario	8.39.13	10,000	1984
Cuchillas del Toa	8.39.13	127,500	1987
Península de Guanahacabibes	8.39.13	101,500	1987
Baconao	8.39.13	84,600	1987

**CZECHOSLOVAKIA**

Krivoklátsko Protected Landscape Area	2.11.05	62,792	1977
Slovensky Kras Protected Landscape Area	2.11.05	36,165	1977
Třeboň Basin Protected Landscape Area	2.11.05	70,000	1977
Palava Protected Landscape Area	2.11.05	8,017	1986
Sumava Biosphere Reserve	2.32.12	167,117	1990
Polana Biosphere Reserve	2.11.05	20,079	1990

**DENMARK/DANEMARK**

North-east Greenland National Park	1.17.09	70,000,000	1977
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**ECUADOR**

Archipiélago de Colón (Galápagos)	8.44.13	766,514	1984
Reserva de la Biosfera de Yasuni	8.05.01	679,730	1989

**EGYPT/EGYPTE**

Omayed Experimental Research Area	2.18.07	1,000	1981
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**EQUATEUR**

Voir paragraphe Ecuador

**ESPAGNE**

Voir paragraphe Spain

**ETATS-UNIS D'AMERIQUE**

Voir paragraphe United States of America

**FRANCE**

Atoll de Taiaro	5.04.13	2,000	1977
Réserve de la biosphère de la Vallée du Fango	2.17.06	25,110	1977
Réserve nationale de Camargue BR	2.17.06	13,117	1977
Réserve de la biosphère du PN des Cévennes	2.09.05	323,000	1984
Réserve de la biosphère d'Iroise	2.09.05	21,400	1988
Réserve de la biosphère des Vosges du Nord	2.09.05	120,000	1988

**GABON**

Réserve naturelle intégrale d'Ipassa-Makokou	3.02.01	15,000	1983
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**GERMAN DEMOCRATIC REPUBLIC**

Middle Elbe Biosphere Reserve	2.11.05	17,500	1979
Vessertal Nature Reserve	2.11.05	7,460	1979

**GERMANY, FEDERAL REPUBLIC OF**

Bayerischer Wald National Park	2.32.12	13,100	1981
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**GHANA**

Bia National Park	3.01.01	7,770	1983
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**GREECE/GRECE**

Gorge of Samaria National Park	2.17.06	4,840	1981
Mount Olympus National Park	2.17.06	4,000	1981

**GUINEA/GUINEE**

Réserve de la biosphère des Monts Nimba	3.01.01	17,130	1980
Réserve de la biosphère du Massif du Ziama	3.01.01	116,170	1980

**HONDURAS**

Río Plátano Biosphere Reserve	8.16.04	500,000	1980
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**HUNGARY/HONGRIE**

Aggtelek Biosphere Reserve	2.11.05	19,247	1979
Hortobágy National Park	2.12.05	52,000	1979
Kiskunság Biosphere Reserve	2.12.05	22,095	1979
Lake Fertő Biosphere Reserve	2.12.05	12,542	1979
Pilis Biosphere Reserve	2.11.05	23,000	1980

**ILE MAURICE**

Voir paragraphe Mauritius

**INDONESIA/INDONESIE**

Cibodas Biosphere Reserve (Gunung Gede-Pangrango)	4.22.13	14,000	1977
Komodo Proposed National Park	4.23.13	30,000	1977
Lore Lindu Proposed National Park	4.24.13	231,000	1977
Tanjung Puting Proposed National Park	4.25.13	205,000	1977
Gunung Leuser Proposed National Park	4.21.13	946,400	1981
Siberut Nature Reserve	4.21.13	56,000	1981

**IRAN**

Arasbaran Protected Area	2.34.12	52,000	1976
Arjan Protected Area	2.34.12	65,750	1976
Geno Protected Area	2.20.08	49,000	1976
Golestan National Park	2.34.12	125,895	1976
Hara Protected Area	2.20.08	85,686	1976
Kavir National Park	2.24.08	700,000	1976
Lake Orumieh National Park	2.34.12	462,600	1976
Miankaleh Protected Area	2.34.12	68,800	1976
Touran Protected Area	2.24.08	1,000,000	1976

**IRELAND/IRELANDE**

North Bull Island	2.08.05	500	1981
Killarney National Park	2.08.05	8,308	1982

**ITALY/ITALIE**

Collemeluccio-Montedimezzo	2.32.12	478	1977
Forêt Domaniale du Circeo	2.17.06	3,260	1977
Miramare Marine Park	2.17.06	60	1979

**JAPAN/JAPON**

Mount Hakusan	2.02.02	48,000	1980
Mount Odaigahara & Mount Omine	2.02.02	36,000	1980
Shiga Highland	2.15.05	13,000	1980
Yakushima Island	2.02.02	19,000	1980

**KENYA**

Mount Kenya Biosphere Reserve	3.21.12	71,759	1978
Mount Kulal Biosphere Reserve	3.14.07	700,000	1978
Malindi-Watamu Biosphere Reserve	3.14.07	19,600	1979
Kiunga Marine National Reserve	3.14.07	60,000	1980

**KOREA, PEOPLE'S DEMOCRATIC REPUBLIC OF**

Mount Paekdu Biosphere Reserve	2.14.05	132,000	1989
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**KOREA, REPUBLIC OF**

Mount Sorak Biosphere Reserve	2.15.05	37,430	1982
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**MADAGASCAR**

Réserve de la biosphère du Mananara Nord	3.03.01	140,000	1990
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**MALI**

Parc national de la Boucle du Baoulé (etc)	3.04.04	771,000	1982
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**MAURITIUS**

Macchabee/Bel Ombre Nature Reserve	3.25.13	3,594	1977
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**MEXICO/MEXIQUE**

Reserva de Mapimí	1.09.07	103,000	1977
Reserva de la Michilía	1.21.12	42,000	1977
Montes Azules	8.01.01	331,200	1979
Reserva de la Biosfera "El Cielo"	1.10.07	144,530	1986
Reserva de la Biosfera de Sian Ka'an	8.16.04	528,147	1986
Reserva de la Biosfera Sierra de Manantlán	8.14.04	139,577	1988

**NETHERLANDS**

Waddensea Area	2.09.05	260,000	1986
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**NIGERIA**

Omo Strict Natural Reserve	3.01.01	460	1977
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**NORWAY/NORVEGE**

North-east Svalbard Nature Reserve	2.25.09	1,555,000	1976
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**UGANDA**

Voir paragraphe Uganda

**PAKISTAN**

Lal Suhanra National Park	4.15.07	31,355	1977
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**PANAMA**

Parque Nacional Fronterizo Darién	8.02.01	597,000	1983
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**PAYS-BAS**

Voir paragraphe Netherlands

**PERU/PEROU**

Reserva de Huascarán	8.37.12	399,239	1977
Reserva del Manu	8.05.01	1,881,200	1977
Reserva del Noroeste	8.19.04	226,300	1977

**PHILIPPINES**

Puerto Galera Biosphere Reserve	4.26.13	23,545	1977
Palawan Biosphere Reserve	4.26.13	1,150,800	1990

**POLAND/POLOGNE**

Babia Gora National Park	2.11.05	1,741	1976
Bialowieza National Park	2.10.05	5,316	1976
Lukajno Lake Reserve	2.10.05	710	1976
Slowinski National Park	2.11.05	18,069	1976

**PORTUGAL**

Paul do Boquilobo Biosphere Reserve	2.17.06	395	1981
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**REPUBLIQUE CENTRAFRICAINE**

Voir paragraphe Central African Republic

**REPUBLIQUE DE COREE**

Voir paragraphe Korea, Republic of

**REPUBLIQUE DEMOCRATIQUE D'ALLEMAGNE**

Voir paragraphe German Democratic Republic

**REPUBLIQUE-UNIE DU CAMEROUN**

Voir paragraphe Cameroon

**REPUBLIQUE-UNIE DU TANZANIE**

Voir paragraphe Tanzania, United Republic of

**ROMANIA/ROUMANIE**

Pietrosul Mare Nature Reserve	2.11.05	3,068	1979
Retezat National Park	2.11.05	20,000	1979
Rosca-Letea Reserve	2.29.11	18,145	1979

**ROYAUME-UNI**

Voir paragraphe United Kingdom

**RWANDA**

Parc national des Volcans	3.20.12	15,065	1983
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**SENEGAL**

Forêt classée de Samba Dia	3.04.04	756	1979
Delta du Saloum	3.04.04	180,000	1980
Parc national du Niokolo-Koba	3.04.04	913,000	1981

**SPAIN**

Reserva de Grazalema	2.17.06	32,210	1977
Reserva de Ordesa-Vinamala	2.16.06	51,396	1977
Parque Natural del Montseny	2.17.06	17,372	1978
Reserva de la Biosfera de Doñana	2.17.06	77,260	1980
Reserva de la Biosfera de la Mancha Humeda	2.17.06	25,000	1980
Las Sierras de Cazorla y Segura BR	2.17.06	190,000	1983
Reserva de la Biosfera de las Marismas del Odiel	2.17.06	8,728	1983
Reserva de la Biosfera del Canal y los Tiles	2.40.13	511	1983
Reserva de la Biosfera del Urdaibai	2.16.06	22,500	1984
Reserva de la Biosfera Sierra Nevada	2.17.06	190,000	1986

**SRI LANKA**

Hurulu Forest Reserve	4.13.04	512	1977
Sinharaja Forest Reserve	4.02.01	8,864	1978

**SUDAN/SOUDAN**

Dinder National Park	3.13.07	650,000	1979
Radom National Park	3.05.04	1,250,970	1979

**SUEDE**

Voir paragraphe Sweden

**SWEDEN**

Lake Torne Area	2.06.05	96,500	1986
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**SWITZERLAND/SUISSE**

Parc national Suisse	2.32.12	16,870	1979
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**TANZANIA, UNITED REPUBLIC OF**

Lake Manyara National Park	3.05.04	32,500	1981
Serengeti-Ngorongoro Biosphere Reserve	3.05.04	2,305,100	1981

**TCHÉCOSLOVAKIE**

Voir paragraphe Czechoslovakia

**THAILAND/THAÏLANDE**

Sakaerat Environmental Research Station	4.10.04	7,200	1976
Hauy Tak Teak Reserve	4.10.04	4,700	1977
Mae Sa-Kog Ma Reserve	4.10.04	14,200	1977



**TUNISIA/TUNISIE**

Parc national de Djebel Bou-Hedma	2.28.11	11,625	1977
Parc national de Djebel Chambi	2.28.11	6,000	1977
Parc national de l'Ichkeul	2.17.06	10,770	1977
Parc national des Iles Zembra et Zembretta	2.17.06	4,030	1977

**UGANDA**

Queen Elizabeth (Rwenzori) National Park	3.05.04	220,000	1979
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**UKRAINIAN SOVIET SOCIALIST REPUBLIC/UKRAINE**

Chernomorskiy Zapovednik	2.29.11	87,348	1984
Askaniya-Nova Zapovednik	2.29.11	33,307	1985

**UNION OF SOVIET SOCIALIST REPUBLICS/****UNION DES REPUBLIQUES SOCIALISTES SOVIETIQUES**

Chatkal Mountains Biosphere Reserve	2.36.12	71,400	1978
Kavkazskiy Zapovednik	2.34.12	263,477	1978
Oka River Valley Biosphere Reserve	2.10.05	45,845	1978
Repetek Zapovednik	2.21.08	34,600	1978
Sikhote-Alin Zapovednik	2.14.05	340,200	1978
Tsentral'nochernozem Zapovednik	2.10.05	4,795	1978
Astrakhanskiy Zapovednik	2.21.08	63,400	1984
Kronotskiy Zapovednik	2.07.05	1,099,000	1984
Laplandskiy Zapovednik	2.03.03	278,400	1984
Pechoro-Ilychskiy Zapovednik	2.03.03	721,322	1984
Sayano-Shushenskiy Zapovednik	2.35.12	389,570	1984
Sokhondinskiy Zapovednik	2.30.11	211,000	1984
Voronezhskiy Zapovednik	2.11.05	31,053	1984
Tsentral'nolesnoy Zapovednik	2.10.05	21,348	1985
Lake Baikal Region Biosphere Reserve	2.04.03	559,100	1986
Tzentralsibirskii Biosphere Reserve	2.03/04	5,000,000	1986
West Estonian Archipelago Biosphere Reserve	2.10.05	1,560,000	1990

**UNITED KINGDOM**

Beinn Eighe National Nature Reserve	2.31.12	4,800	1976
Braunton Burrows National Nature Reserve	2.08.05	596	1976
Caerlaverock National Nature Reserve	2.08.05	5,501	1976
Cairnmore of Fleet National Nature Reserve	2.08.05	1,922	1976
Dyfi National Nature Reserve	2.08.05	1,589	1976
Isle of Rhum National Nature Reserve	2.31.12	10,560	1976
Loch Druidibeg National Nature Reserve	2.31.12	1,658	1976
Moor House-Upper Teesdale Biosphere Reserve	2.08.05	7,399	1976
North Norfolk Coast Biosphere Reserve	2.08.05	5,497	1976
Silver Flowe-Merrick Kells Biosphere Reserve	2.08.05	3,088	1976
St Kilda National Nature Reserve	2.08.05	842	1976
Claish Moss National Nature Reserve	2.31.12	480	1977
Taynish National Nature Reserve	2.31.12	326	1977

**UNITED STATES OF AMERICA**

Aleutian Islands National Wildlife Refuge	1.12.09	1,100,943	1976
Big Bend National Park	1.09.07	283,247	1976
Cascade Head Experimental Forest			
Scenic Research Area	1.02.02	7,051	1976
Central Plains Experimental Range (CPER)	1.18.11	6,210	1976
Channel Islands Biosphere Reserve	1.07.06	479,652	1976
Coram Experimental Forest (incl. Coram NA)	1.19.12	3,019	1976
Denali National Park and Biosphere Reserve	1.03.03	2,441,295	1976
Desert Experimental Range	1.11.08	22,513	1976
Everglades National Park			
(incl. Ft. Jefferson NM)	8.12.04	585,867	1976
Fraser Experimental Forest	1.19.12	9,328	1976
Glacier National Park	1.19.12	410,202	1976
H.J. Andrews Experimental Forest	1.20.12	6,100	1976
Hubbard Brook Experimental Forest	1.05.05	3,076	1976

Jornada Experimental Range	1.09.07	78,297	1976
Luquillo Experimental Forest (Caribbean NF)	8.40.13	11,340	1976
Noatak National Arctic Range	1.13.09	3,035,200	1976
Olympic National Park	1.02.02	363,379	1976
Organ Pipe Cactus National Monument	1.08.07	133,278	1976
Rocky Mountain National Park	1.19.12	106,710	1976
San Dimas Experimental Forest	1.07.06	6,947	1976
San Joaquin Experimental Range	1.07.06	1,832	1976
Sequoia-Kings Canyon National Parks	1.20.12	343,000	1976
Stanislaus-Tuolumne Experimental Forest	1.20.12	607	1976
Three Sisters Wilderness	1.20.12	80,900	1976
Virgin Islands National Park & Biosphere Reserve	8.41.13	6,127	1976
Yellowstone National Park	1.19.12	898,349	1976
Beaver Creek Experimental Watershed	1.08.07	111,300	1978
Konza Prairie Research Natural Area	1.18.11	3,487	1979
Niwot Ridge Biosphere Reserve	1.19.12	1,200	1979
The University of Michigan Biological Station	1.18.11	4,048	1979
The Virginia Coast Reserve	1.05.05	13,511	1979
Hawaii Islands Biosphere Reserve	5.03.13	99,545	1980
Isle Royale National Park	1.22.14	215,740	1980
Big Thicket National Preserve	1.06.05	34,217	1981
Guanica Commonwealth Forest Reserve	8.40.13	4,006	1981
California Coast Ranges Biosphere Reserve	1.02.02	62,098	1983
Central Gulf Coastal Plain Biosphere Reserve	1.06.05	72,964	1983
South Atlantic Coastal Plain BR	1.06.05	6,125	1983
Mojave and Colorado Deserts Biosphere Reserve	1.08.07	1,297,264	1984
Carolinian-South Atlantic Biosphere Reserve	1.06.05	125,545	1986
Glacier Bay-Admiralty Is. Biosphere Reserve	1.01.02	1,515,015	1986
Central California Coast Biosphere Reserve	1.07.06	404,863	1988
New Jersey Pinelands Biosphere Reserve	1.05.05	445,300	1988
Southern Appalachian Biosphere Reserve	1.05.05	215,596	1988
Champlain-Adirondak Biosphere Reserve	1.05.05	3,990,000	1989
Mammoth Cave Area	1.09.07	83,337	1990
<b>URUGUAY</b>			
Bañados del Este	8.32.11	200,000	1976
<b>YUGOSLAVIA/YUGOSLAVIE</b>			
Réserve écologique du Bassin de la Rivière Tara	2.33.12	200,000	1976
Velebit Mountain	2.17.06	150,000	1977
<b>ZAIRE</b>			
Réserve floristique de Yangambi	3.02.01	250,000	1976
Réserve forestière de Luki	3.02.01	33,000	1979
Vallée de la Lufira	3.06.04	14,700	1982

285 reserves in 72 countries, total area = more than 152,783,755 ha  
285 réserves dans 72 pays, superficie totale = plus de 152,783,755 ha

## ALGERIA

**NAME** Parc national de Tassili N'Ajjer  
(includes the réserves naturelles du Iherir et Azarif and Tamrit Séfar)

**IUCN MANAGEMENT CATEGORY** II (National Park)  
IX (Biosphere reserve)  
X (World Heritage Site)

**BIOGEOGRAPHICAL PROVINCE** 2.18.07 (Sahara)

**GEOGRAPHICAL LOCATION** South-eastern part of the Algerian Sahara near the frontiers with Nigeria and Libya (in the wilayates of Ouargla, Djanet and Tamanrassat, the da'ira of In-Amenas and the da'ira of Djanet). Tassili is situated between Illezi to the north and Djanet to the south. The park and massif is shaped roughly like a triangle, whose longest side measures 700km from Amguid to the frontier with Nigeria. The national park is 60km in length from Djanet to the Libyan frontier. The boundary runs from beyond the high ridge overlooking the Ergs of Admer and Tihodaine, then runs to the south and to the east along the frontiers with Nigeria and Libya. The east-west bounds run from Tarat to Amguid via Illizi. 23°00'N-26°50'N, 5°20'E-12°00'E

**DATE AND HISTORY OF ESTABLISHMENT** The entire site was established as a national park by Ministry of Culture Decree No. 72-168 on 27 July 1972 and further designated as an historic monument in December 1979. In 1986 the site was further covered under Governmental nature conservation and national park legislation of Decree No. 83-458. Tassili N'Ajjer was accepted as a World Heritage site in 1982, and as a biosphere reserve in October 1986.

**AREA** 7,200,000ha. Extended from the 1972 area of 300,000ha with the acceptance of Tassili Plateau as a biosphere reserve (prior to that date the area totalled 80,000ha).

**LAND TENURE** State property (rights of pasture land-use have been given to the nomadic tribes of the region). Local tribes people are the main landowners in the oases and the centres of cultivation.

**ALTITUDE** 1,150m-2,158m. The altitude of the plateau varies from about 1,500m in the north and north-west to 1,800m in the centre and south.

**PHYSICAL FEATURES** The area covers the Tassili Plateau which runs a distance of 700km from north-west to south-east, an average of 100km in width. Tassili is a mountainous region in the centre of the Sahara, to the east of the Hoggar massif. The Tassili, or plateau, forms part of the Ordovician and Devonian sandstone layer which surrounds the Precambrian crystalline massif which constitutes the Hoggar. It comprises a series of plateaux where all the cliffs lie in a west-north-west/east-south-east direction: the inner and the outer Tassili are separated by the Intra-Tassilian Trench of clay-sandstones (Fabre, 1978). The plateau owes its morphological structure and its unique network of steep-sided valleys to a succession of wet and dry periods in palaeoclimatic wet periods. At the end of the Upper Pleistocene period, there were huge lakes in the region, in what are today the great Ergs. The lakes were fed by rivers flowing down from the Tassili. For the last 10-15,000 years, the whole area has become steadily drier, although this process was alleviated to some extent by a slightly more humid period from 4,000 to 2,000BC. In some areas flat plateaux have been formed by fluvial action,

their surfaces furrowed by narrow, deep gorges and dry river beds. Elsewhere wind erosion and the arid climate have strewn the plateaux with rock formations resembling ruins, known as "stone forests" (Dubief, 1959, 1963; Fabre, 1978). In the south-south-west part of the reserve, the plateau rises up in an impressive escarpment some 600m above the ergs (shifting sand dunes). Relatively recent volcanic deposits cover the sandstones and form the Adrar massif of 2,158m. Water is always present in this region, remaining in deep shaded rocky chasms and oueds. The only perennial river in the central Sahara is at Iherir. In the fresh-water areas of the Iherir valley aquatic mosses secrete travertine which forms natural dams and lakes cascading from one level to another (Kerzabi, 1986).

**CLIMATE** The plateau is hyper-arid, but there are sub-arid microclimates suitable for the survival of relict Mediterranean fauna and flora. Mean annual rainfall is 30mm and mean annual temperature is 20.3°C at an altitude of 1,100m. The plateau tends to be very exposed and arid although there are areas of locally high humidity. There are exceptional annual 20mm rainfall levels (Verschuren, 1984).

**VEGETATION** Deep humid microclimates have resulted in a number of valleys remaining green. The Saharan flora has elements of Mediterranean, Sudano-Deccan and Saharo-Sindien species (Leredde, 1957; Ozenda, 1958). The mountains (Hoggar and Tassili) support a complex relict flora with a combination of all three elements. The most notable palaeo-endemic relict Saharan-Mediterranean flora tree species are cypress "tarout" Cupressus dupreziana, of which there are about 240 specimen left in the world, wild olive Olea laperrini and myrtle Myrtus nivellei (Barry *et al.*, 1970). There are about 100 cypress specimen left in the "Valley of the Cypresses" at Tamrit, as well as in two other valleys south of the park (Kerzabi, 1986). Olive Olea laperrini and myrtles Myrtus nivellei grow at the bottom of wadis or beside gueltas (permanent or temporary waterholes which exist after rainfall). Other river-bed species include Trianthema pentandra, Silene kiliana, Lupinus pilosus and Convolvulus fatmensis (Ozenda, 1958; Zeraia, 1983). The Iherir valley, being comparatively humid, also contains riverine species such as Typha spp., Juncus spp., Phragmites spp., Adiantum and aquatic vegetation such as Chara spp., Myriophyllum spp. and Potamogeton spp. (Ozenda, 1958; Kerzabi, 1986). In the extremely unpolluted fresh water of the Iherir valley, aquatic mosses give rise to travertine dams, waterfalls and pools (Kerzabi, 1986). There are also many Sudanese flora elements such as the genera Merrua, Salvidora and Callotropis. Rocky and sand species include Mesembryanthemum gaussonii, Pseuderucaria clavata and Acacia scorpiodes (Leredde, 1957; Ozenda, 1958; Quezel, 1962; Zeraia, 1983). Other endemic Saharan species found on the massif include Potamogeton hoggariensis, Silene hoggariensis, Lupinus tassilicus and Senecio hoggariensis (Ozenda, 1977).

The Tassili is important for its 28 national plant rarities. Amongst these threatened species are Ficus ingens, Boerhaavia viscosa, Trianthema pentandra, Spergularia fontenellei, Bergia suffruticosa, Hypericum psilophyton, Olea laperrina, Convolvulus fatmensis, Anticharis glandulosa and Utricularia exoleta (see lists in Zeraia, 1983; Dobr, 1988). The most threatened plants include Cupressus dupreziana and Phagnalon garamantum (Mathez *et al.*, 1985).

**FAUNA** The fauna contains elements originating from both the Mediterranean and the Saharan Palaearctic realm. Species relict of a more humid climate include fish, shrimp and once even a dwarf Saharan crocodile Crocodylus niloticus (Kerzabi, 1986). There are large numbers of spiders, insects and reptiles. The distribution of the crocodile was many thousands of kilometres from the next nearest population in Egypt. The last crocodile specimen were killed on the Imirhou wadi in the 1940s and on the Iherir in the mid-19th century (Kerzabi,

1986). Fish are found in the permanent river/gueltas in the region of Iherir. There are four fish species of the Tilapia family as well as two species of amphibians including the nationally threatened Ctenodactylus vali (LeBerre et Bouvet, 1985; LeBerre, 1986, cited in Kerzabi, 1986). Dragonflies in the area include Orthetrum ransonneti and O. sabina (Aguilar et al, 1986). The 23 or so larger mammal species are more typical of arid climates and include Barbary sheep Ammotragus lervia (V) (once thought extinct in the area), caracal Felis caracal, cheetah Acinonyx jubatus (V) and dorcas gazelle Gazella dorcas (V) (MNN, 1983; de Smet, 1989). Locally threatened species include gundi Ctenodactylus vali and large-toothed rock dassy or hyrax Procavia capensis (P. syriaca) (de Smet, 1984). Roan antelope Hippotragus equinus, addax Addax nasomaculatus (E) and scimitar oryx Oryx dammah (E) have disappeared from the region (MNN, 1983; de Smet, 1984). In February 1987 two dead specimen of the extremely threatened scimitar-horned oryx Oryx dammah (E) were found by the director of the park on a road south of the park boundary (de Smet, pers. comm., 1987). Other observations of this species have been made near Ain-Amenas (MNN, 1983).

The entire region is important for resting migratory Palaearctic birds. Species recorded in the area include golden eagle Aquila chrysaetos, long-legged buzzard Buteo rufinus, bittern Botaurus stellaris, little bittern Ixobrychus minutus, night heron Nycticorax nycticorax, squacco heron Ardeola ralloides, purple heron A. purpurea, white stork Ciconia ciconia, glossy ibis Plegadis falcinellis, short-toed eagle Circus gallicus, lesser kestrel Falco naumanni, hobby F. subbuteo, quail Coturnix coturnix, spotted crane Porzana porzana, corncrake Crex crex and stone curlew Burhinus oedipnemus (Ledant et al., 1985). Breeding bird species include Palaearctic marsh birds, such as coot Fulica atra and moorhen Gallinula chloropus, as well as a relict sub-species of Barbary partridge Alectoris barbara duprezii (Etchécopar et Hùé, 1964; Ledant et Jacob, 1982; de Smet, in litt., 1987; de Smet, 1989).

**CULTURAL HERITAGE** The entire site is of international importance for a series of ancient cave paintings. The most noteworthy pre-historic remains include: rock paintings in the national park and the Plateau of Tasghirt, rock engravings of large fauna (hippopotamus, buffalo, elephant, rhinoceros and giraffe) and of man in the wadi Djerat canyon, rock engravings of the fauna of the Sahara on the Plateau of Dider, stone monuments at Fadnoun, rich archaeological remains in the southern zone, neolithic remains such as sculpture, pottery, grinding implements and enclosure walls as well as material from the lower and middle Paleolithic periods in the Fort Tarat and Djanet regions (Anon., 1986). A chronological sequence in cave paintings exists, for example those of the Equidian period present stylised figures and frequent scenes of moufflon hunting; the Cameline period with a schematic style incorporating inscriptions in Tifinagh characters, which is the same alphabet as still used by the Tuareg today. Radio-carbon dating has indicated the archaeological remains date from the period 6,000 to 2,000BC (Lhote, 1973; Anon, 1986).

**LOCAL HUMAN POPULATION** The total population of the plateau is approximately 1-3,000 (Anon, 1986; Kerzabi, 1986). The area is very sparsely inhabited by sedentary and nomadic Tuaregs. The cultivated areas are centred around some gueltas or the valleys of certain wadis. The Da'ira of In-Amenas and the Da'ira of Djanet together cover most of the plateau and have around 10,000 inhabitants (Djanet town with a population of 5,000). Stock raising and agriculture are confined to the centres, while grazing is confined generally to the wadi floor. Tourism is becoming an important source of revenue for the local population (Anon., 1986).

VISITORS AND VISITOR FACILITIES The number of tourists is increasing continually and an international aeroport has been constructed at nearby Djanet to cater for this growth industry. Crossing the massif is generally only practicable for four-wheel drive vehicles. The park tourism office (OPNT), which controls and supervises tourists, is located in Djanet.

SCIENTIFIC RESEARCH AND FACILITIES An experimental centre has been set up at the archaeological site of Timenzouine (Tassili of Djanet) where a meteorological station has operated since 1979 (Kerzabi, 1986). In January 1987 Dr B. Bosquet, an Unesco consultant, worked with the national authorities to examine the needs for conservation on the Tassili massif and to subsequently produce draft recommendations (MAB Algeria, 1987). Since 1987 a project has been underway to sustain and re-introduce Tarout cypress (Cupressus dupreziana) to the Tassili plateau with WWF/IUCN assistance (Project No II 3781, 1987). Tarout cypresses on the plateau have already been catalogued and numbered (Kerzabi, 1986; Dobr, 1988). It is planned to establish a station within the reserve which will act as a base for studies on the flora and fauna. At present, most facilities are located in the surrounding villages. Ongoing studies include ageing by dendochronology of Duprey cypress, natural resource inventories and conservation of the rock-art (Anon., 1986).

CONSERVATION VALUE The site was first established as a national park in order to protect its internationally important cultural heritage. It was subsequently realised that the area was also internationally important for its geology, fauna and flora. Some of the important elements of the park include the geological formations which are of outstanding scenic interest (precambrian crystalline formation and eroded sandstones). The Tassili is important for wildlife and includes 28 national plant rarities and one internationally threatened plant species and over five endangered mammal species (see lists in Zeraia, 1983; Ledant et Jacob, 1982; MNN, 1983; Mathez et al., 1985; de Smet, pers. comm., 1987). The entire region is important for resting migratory Palaearctic birds. Cupressus dupreziana is one of 12 critically endangered plants selected by IUCN's Species Survival Commission to highlight the serious threats to species around the world (Dobr, 1988). The entire site is of international importance for a series of ancient cave paintings.

CONSERVATION MANAGEMENT Management plans exist for one area of the Tassili, near Djanet, where wardens and guides manage visitor movements. Studies are currently underway to produce a combined management plan for the natural and cultural aspects of the national park (MAB Algeria, 1987). A management plan for the whole plateau is under preparation with the aim of giving priority to protecting the most sensitive areas. Zones have not yet been delineated, but buffer areas are planned that include areas of ergs that surround the area: Erg Admer to the south-south-west, Erg Tihodaine to the south-west and Erg Isaouane to the north. Work on the management plan has included a seminar held in Djanet from 22-27 December 1986 and work by a Unesco consultant in January 1987 with the national authorities (MAB, 1987).

Regulations afford protection to the ancient rock paintings and a number of bylaws exist to restrict hunting, grazing and timber exploitation (Drucker, pers. comm., 1987). There is no effective wildlife management and an urgent need to protect threatened species such as the endemic Ctenodactylus vali. OPNT is undertaking work to protect the rock paintings. Teams are sent to explore unvisited zones preparatory to drawing up inventories of rock paintings. Attempts are being made to aggregate sites in sectors for purposes of supervision and ease of management.

MANAGEMENT CONSTRAINTS The ecosystems of the area are very fragile and are vulnerable to changes in the equilibrium between the human population and the environment. The impact of tourism poses a problem, particularly litter and the threat to resources such as cypress, which is attractive to collectors. Due to the changing climatic conditions, species such as Cupressus dupreziana are incapable of reproducing in their natural surroundings and will eventually become extinct unless conservation measures succeed. Pollution is affecting the moss-formed travertine in the Guelta of Azarif (Kerzabi, 1986).

STAFF 44 staff members including the director (Anon., 1986). OPNT has a director and research officer as well as wardens stationed at Djanet, Illizi, Zawatazz and Iherir. The wardens act as guides and ensure that measures taken to protect archaeological sites and the fauna and flora are respected.

BUDGET The OPNT is financially independent. Its budget allocation covers staff salaries, maintenance of a small fleet of vehicles and upkeep of a herd of camels and donkeys. Resources earmarked for conservation purposes are extremely limited and are devoted to documentation, purchase of essential equipment and the living expenses of experts on projects.

LOCAL ADDRESSES Office du Parc national du Tassili (OPNT), Djanet  
Office du Parc national du Tassili (OPNT), Park Zyriab, Bd., Salah Bouakour, Alger  
Sub-Directorate of Historical Monuments and Sites, Ministry of Information and Culture, Alger

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## ARGENTINA

NAME Reserva de la Biosfera Laguna de Pozuelos

IUCN MANAGEMENT CATEGORY III (Natural Monument)  
IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 8.16.12 (Puna)

GEOGRAPHICAL LOCATION Situated in the uplands of Jujuy Province. Its natural limits, from north to south, are the high peaks of the Sierras de Cochinoca, Quichagua and San José. The core area, comprising the Pozuelos-Sarcari, Escaya, Carahuasi, Sierra de Cochinoca and Mesadas areas, includes the Pozuelos basin together with part of the main lower tributaries, part of the east pie demonte, the small upland lagoon system and the head waters of Rio Santa Catarina. 22°15'-22°27'S, 65°56'-66°03'W

DATE AND HISTORY OF ESTABLISHMENT Established as a natural monument in 1981 under Provincial Law No. 3749 and approved as an international biosphere reserve by the MAB Bureau in February 1990.

AREA 400,000ha (core zone 56,400ha, buffer zone 234,400ha and transition zone 109,200ha)

LAND TENURE Eighty per cent of the core area is government-owned. Ownership of the remaining 20% is unknown and is presumed private; the transition zone is mainly private.

ALTITUDE 3,600m-4,800m

PHYSICAL FEATURES Laguna de Pozuelos is an endorreic basin, with large underground water resources. Rio Santa Catarina-Sarcari to the north and Rio Cincel to the south of the reserve are the main tributaries. The lagoon is also a large, highly permeable seasonal water catchment area with ample alluvial fans of thick material. There is evidence of volcanic activity in the form of tabular and dome lava. Characteristic environments of the area include the wide upper valley of Rio Santa Catarina-Sacari, the corridor occupied by a large number of small freshwater lagoons which are found in the foothills of the Sierra de Rinconada, and the south-west sector, dominated by an ancient volcanic landscape (Tecchi et al., 1989). The surrounding mountain chain is a tectonic formation from the Tertiary period, modified by irregular erosive processes which possibly accumulated dense layers of sand and other material in the valleys. Some peaks in the area are higher than 4,500m, but are not higher than 400m or 500m above the plateau (Merino, 1987).

CLIMATE Conditions are severe with marked seasons; dry in winter and wet in summer. The lagoon changes in size according to the seasons, its maximum area in the wet season is approximately 70 sq.km. Waters are highly saline due to high evaporation rates and to the influx of saline waters from Rio Cincel. Mean annual temperatures range from 9°C in the depressions to 4°C in the high peaks. Mean annual rainfall is 300mm (maximum 400mm). The rainy season lasts from October to March turning the area into the wettest in the Argentinian uplands. By contrast, there is drought in some years (Tecchi et al., 1989).

**VEGETATION** Part of the Andean Domain (Merino, 1987), it has more than 70% vegetation cover, surprising for a semi-arid area, represented mainly by arbustive steppe, with shrubs less than 60cm in height, such as Fabiana densa and Baccharis biliviensis, grasses Poa sp., Festuca sp., Distichlis sp., Stipa sp., some species of 'tola' Parastrephia such as P. lepidophylla and P. phyllicaeformis, and some graminaceous plants such as Oxichloe sp. (Merino, 1987; Tecchi et al., 1989). Cardones Trichocereus spp. are found in the lowest foothills of the mountain chain surrounding the depression, as well as 'mocaraca' Senecio viridis, 'reca reca' Accantholeppia hastulata, 'añagüilla' Adesmia spinossisima and 'yareta' Azorella compacta (Merino, 1987). The only species of shrub found above 4,000m is 'queñoa' Polylepis tomentella. Aquatic plants are also important, especially in the area of the lagoon, where Myriophyllum sp. is the main genus present (Tecchi et al., 1989). Cactaceae, such as 'airampu' Opuntia soehrensii, are representative of this type of ecosystem, although they are scarce at the altitude of the lagoon proper (Merino, 1987; Tecchi et al., 1989).

**FAUNA** Twenty species of birds include James' or Puna flamingo Phoenicoparrus jamesi, Andean flamingo P. andinus and Chilean flamingo Phoenicopterus chilensis, which occurs in large numbers (26,000 birds present at one time). Chilean flamingos are the most numerous of the flamingos with the other species only occurring in their hundreds (Scott and Carbonell, 1986). There are also Andean goose Chloephaga melanoptera, Andean avocet Recurvirostra andina, American coot Fulica americana, giant coot F. gigantea and horned coot F. cornuta which nests in the area (Scott and Carbonell, 1986; Merino, 1987; Tecchi et al., 1989). More information on the birds of the area can be found in Scott and Carbonell (1986). Migratory ducks and waders, such as Wilson's phalarope Phalaropus tricolor, are also present. Raptors include hawks Buteo sp., burrowing owl Speotyto cunicularia, condor Vultur gryphus and lesser rhea or suri Pterocnemia pennata garleppi (Tecchi et al., 1989). Mammals include vicuña Vicugna vicugna (V), tucos Ctenomys opimus, Colpeo fox Dusycion culpaeus, Cape hare Lepus europaeus europaeus, hairy armadillo Euphractus nelsoni, mountain viscacha Lagidium viscaccia, leaf-eared mouse Phyllotis darwini and puma Felis concolor (Merino, 1987; Tecchi et al., 1989).

**CULTURAL HERITAGE** At least seven archaeological sites are present in the basin. It is thought to have been an area of great agricultural activity, a theory supported by the large number of Precolombian roads. This zone used to supply the basic needs of the travellers and their domestic animals during their long travels (Tecchi et al., 1989).

**LOCAL HUMAN POPULATION** Approximately 3,600 people of indigenous origin inhabit the area, with the largest concentrations in villages not larger than 400 people. Population density, depending on various factors, ranges from 0.5 to 1.5 per sq. km, the highest in the Argentinian rural uplands. The majority are farmers, mainly of sheep and llamas, although goats and cattle supplement their herds. Donkeys, formerly abundant, are now scarce. Alpaca rearing may occur but is not separated from llama rearing. Small-scale mining for gold is carried out in some of the streams in the Sierra de Rinconada. Main activities are the production of meat and fibre (mainly Abrapampa) and are destined for regional markets. Additionally, there is seasonal human migration to and from the area as a result of agricultural activities (sugar cane and tobacco), and large-scale mining operations (Tecchi et al., 1989). Queñoa is exploited for fuelwood or for construction timber and has been reduced to the higher cliffs. Other species also used for fuel include Parastrephia sp., Baccharis sp., Senecio viridis, Accantholeppia hastulata, Adesmia spinossisima and Azorella compacta (Merino, 1987).

VISITORS AND VISITOR FACILITIES An extensive network of roads links the basin to all neighbouring regions. Two main roads link Pozuelos with La Quiaca and Bolivia to the north-east and Abapampa and the rest of the country to the south-east, via national road No.9. Within the basin, roads link the main towns and hamlets through the plains and along the foothills. There is also a network of secondary roads which link more inaccessible intermontane areas with the main roads (Tecchi et al., 1989). Tourist potential is high as the concentration of vicuñas and especially of flamingos turns the area into an attractive landscape (Merino, 1987). A project to build the Sarcari Tourist and Community Centre, using improved traditional techniques, is planned and will include a hostel, museum and reserve offices. A programme for environmental education is also planned and will include training for primary schools teachers and for local leaders on environmental problems and media participation. A basin resource database will be included (Anon., 1989).

SCIENTIFIC RESEARCH AND FACILITIES Research is directed towards the study of upland ecosystem dynamics and to the factors which determine its horizontal and vertical spatial distribution. Studies of faunal population dynamics include aquatic avifauna, vicuña and suri. Specific research into the genetics of domestic camelids forms an important element. In addition, surveys will be carried out on amphibian, reptilian and fish species, and an inventory of aquatic arthropods (Anon., 1989). Regarding flora, the main aims are to assess the productive capacity of the various ecosystems, in particular, a study into the possibility of increasing the area of 'queñoa' (Polylepis tomentella) forest, as well as the dynamics of woody shrubs and ethnobotany in general. Research on geology, soils, geomorphology, cultural and social aspects is also underway (Anon., 1989). A scientific station (Estacion Cientifica Pozuelos) will be built and will have accommodation for scientific staff, a laboratory, store house, an agricultural experimental field and a climatological station. This building will use traditional techniques and solar energy (Anon., 1989).

CONSERVATION VALUE The lagoon is probably the most important wetland for waterfowl in the northern Andes, with large numbers of breeding and migratory birds from elsewhere in the Andes and the Nearctic Region (Scott and Carbonell, 1986).

CONSERVATION MANAGEMENT First established as a natural monument to protect migratory birds, an area which only included the actual water body and a narrow margin surrounding the lagoon. The biosphere reserve aims to protect the whole of the basin, its flora and fauna, with the participation of the local population at all levels (Anon., 1989). There are three management areas, the core zone which represents 14% of the area of the reserve, the buffer zone representing 58.6% and the transitional zone the remaining 27.3%. The core zone includes the actual basin and the lower tributaries. The buffer zone mainly includes the mountain areas used for pasture with little other environmental disturbances, and the lower zones subject to flooding. The transitional zone includes land suitable for agriculture and rich in fodder; this area is mainly privately-owned (Anon., 1989). A programme has been developed to gather baseline data on this upland ecosystem, to study the effects and influence of innovative over traditional use, to contribute to the establishment of monitoring ecological and socio-cultural variables and to produce resource management and action guidelines (Tecchi et al., 1989). This information will be the basis for the gradual increase in protection for the various areas within the reserve (Anon., 1989). The present research cycle started in 1985 as a joint effort between Argentina and Chile and an exchange programme was established with support from MAB and now also includes the participation of institutions from Spain and the USA. The central problem is the

existence of a traditional natural resource system with high cultural significance. This system is already having an impact on the ecosystem with increased technology and external social pressures. Thus, activities in the basin have been structured so that a certain amount of development can take place. These activities include breeding of domestic camelids, improving construction techniques (scientific station and a tourist complex) and environmental education (Anon., 1989; Tecchi et al., 1989). A preliminary management plan has been drawn up with the participation of the local population in the basin, to provide further information, and its objectives will be carried out within a two-year period (Anon., 1989). Additionally, buffer and transition zones will be classified for planning the following activities as far as possible: moderate and intensive camelid ranching, pasture planting, woody shrub management, queñoa re-planting, tourism and restoration of mining areas. Traditional alluvial areas for gold extraction are being left as they are considered an added tourist attraction (Anon., 1989).

A project for the establishment of the Commission for the Development of the Pozuelos Basin is also underway. This commission will be formed by representatives of the local population, university researchers (Universidad Nacional de Jujuy) and the Provincial Executive Office (Anon., 1989). Its main mission will be to coordinate conservation and development in the basin. The control of the areas of preservation of its natural and cultural heritage is among one of its anticipated objectives, and it is expected that the commission will start activities in the first part of 1990. Meanwhile, the Programa de Ecología Regional of the Universidad Nacional de Jujuy will continue to administer the reserve (Anon., 1989).

Traditional Andean transhumance and seasonal ranching occurs, with llama, sheep, goat and cattle as the main stock. Meat and fibre production supplement the income. During the last 25 years, the government has been introducing high quality sheep to improve reproductive efficiency and quality in meat and wool production. At the same time, it has introduced exotic pastures in enclosed areas covering about 3% of the area of the basin. Mining for gold is also relatively important. The local population has a deep traditional knowledge of the natural resources and their use (Tecchi et al., 1989).

**MANAGEMENT CONSTRAINTS** Desertification and reduction of the steppe arbustive cover by heavy grazing by domestic animals, severe soil erosion resulting from past overgrazing and the action of strong winds, which increased siltation rates (Merino, 1987; Scott and Carbonell, 1986). Neglect of old cultivation terraces as a result of reduced production has also caused erosion problems (Merino, 1987). Gold extraction areas, especially alluvial, are potentially a source of pollution in the form of increased siltation and detrimental water quality.

**STAFF** None at present, but there are plans to have 19 people working there in the next ten years (1 intendent, 8 park rangers, 2 replacement park rangers, 1 head of park rangers, 2 administrative and 5 general workers) (Merino, 1987). There is a building for reserve wardens to the south of the lagoon (Tecchi et al., 1989).

**BUDGET** No recent information, although in 1983, the budget was 20,962 Argentinian pesos (Merino, 1987).

**LOCAL ADDRESSES** Programa de Ecología Regional, Instituto de Biología de la Altura, Universidad Nacional de Jujuy, Avenida Bolivia No. 2335/46 - T.E. 27244, 4600 San Salvador de Jujuy

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## BOLIVIA

NAME Beni

IUCN MANAGEMENT CATEGORY

IV (Managed Nature Reserve)

IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 8.35.12 (Andean Cloud Forest)

GEOGRAPHICAL LOCATION The site is in the provinces of Ballivian and Yacuma, within the Department of Beni. The south boundary runs parallel to the San Borja - San Ignacio de Moxos highway. Maniqui River forms the west boundary and Chirigua Creek the eastern boundary. Neighbouring human settlements include San Borja. 14°38'S, 66°18'W

DATE AND HISTORY OF ESTABLISHMENT Established as a biosphere reserve on 5 October 1982, by Supreme Decree 19191 of the Presidency of the Republic. Accepted as a biosphere reserve in October 1986.

AREA 135,000ha

LAND TENURE State

ALTITUDE 220-235m

PHYSICAL FEATURES The geology consists of quaternary alluvial sediments deposited on a thin Precambrian shield. Soils are of low or medium fertility (Cochrane, 1973). This is a lowland system, the first mountain range of the Eastern Sub-Andean foothills is found 50km to the south-west. The land is largely flat, with some poorly drained areas and some higher zones. There are terraced river banks along the Maniqui.

CLIMATE Mean annual temperature is 27°C and mean annual precipitation is 1800mm, both recorded at an altitude of 226m. The dry season lasts from April to October.

VEGETATION Consists of components of Hylea of northern Brazil, together with components of the sparse forest of Central Brazil (Cerrado) and Paraguay-Argentina (Chaco). Forest systems represented include: tropical forest, characterised by species such as ochoo Hura crepitans, mara Swietenia macrophylla and motacu Athalea princeps; gallery forest; forest islands of deciduous trees; lowland dense forest characterised by palo maria Calophyllum sp., guayabochi Calycophyllum spruceanum, chonta Acrocomia sp.; open middle-height forest (5-15m), which forms the transition zone between forest and savanna, characterised by tajibo Tabebuia sp., mapajo Curatella americana, Pseudobombax sp.; matorral formations in the intermediary zones with the open forest characterised by tuzequ Machaerium sp.; extensive savannas in the south-east of the reserve and poorly drained lowland zones that support swamp and wetland species. About 1,000 species of vascular plants are estimated to be present.

FAUNA Located in a transition zone between different habitats, the reserve supports a diverse fauna. There are about 100 species of mammals and 300 species of birds in the area. Eighty-nine species of fish have been identified and 26 species of bush amphibians and reptiles. Mammals include bush dog Speothos venaticus (V), maned wolf Chrysocyon brachyurus (V), marsh deer Odocoileus dichotomus, jaguar Panthera onca (V), and giant armadillo Priodontes maximus (V).

Noteworthy birds include greater rhea Rhea americana, peroqui Cathartes melambrotus, harpy eagle Harpia harpyja (R), tapacare Chauna torquata, toucan Ramphastos toco, blue-and-yellow macaw Ara ararauna, green-winged macaw A. chloroptera, chestnut-fronted macaw A. severa, water serer Opisthocomus hoazin, jabiru Jabiru mycteria, maguari stork Euxenura maguari and royal egret Pilherocius pileatus. Among the reptiles are some of the most spectacular species of the Neotropics, including pucarara Lachesis muta, anaconda Eunestes murinus and black caiman Melanosuchus niger (E).

CULTURAL HERITAGE No information

LOCAL HUMAN POPULATION Approximately 20 families of Chimane aborigines live in the reserve. They live mainly along the Curiraba and Maniquisito rivers and are primarily hunter-gatherers and also practise a type of itinerant agriculture. Farmers of surrounding areas exert pressure on the reserve's periphery by setting up cattle ranches and plantations.

VISITORS AND VISITOR FACILITIES The reserve is more accessible during the dry season between April and October. Maniqui River provides access throughout the year, but Curiraba Creek does so only during the rainy season.

SCIENTIFIC RESEARCH AND FACILITIES Scientific research has been treated as a priority since it is the major support to the protection of the area. Ongoing research lies in improving knowledge of unknown tropical areas. The presence of forest ethnic groups makes this reserve an important area for anthropological and socio-economic studies. Beni has facilities for meteorological and other research, with accommodation for up to 15 scientists. El Porvenir, ranch adjacent to the reserve, provides for the development of scientific projects in agriculture, forestry and animal husbandry for the benefit of the region.

CONSERVATION MANAGEMENT The dense high forest has been left largely undisturbed due to the difficulty of access. The savanna, however, is used for raising cattle by a limited number of private ranchers. There is some forestry activity, limited to areas along the access routes.

MANAGEMENT CONSTRAINTS The forests of South America are under severe pressure from settlers who attempt to clear the forest and turn the land to agricultural or stock production. In Bolivia there is a flow of people down from the hills seeking land of their own. Although the reserve is relatively inaccessible, pressures for new land are likely to rise in the future, making protection more necessary.

STAFF Seven, three based in La Paz and four in the field

BUDGET No information

LOCAL ADDRESSES Estación Biológica Beni, av 16 de Julio 1732, Casilla 5829, LA PAZ

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## BURKINA FASO

NAME Forêt Classée de la Mare aux Hippopotames

IUCN MANAGEMENT CATEGORY VIII (Multiple Use Management Area)  
IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 3.04.04 (West African Woodland/Savanna)

GEOGRAPHICAL LOCATION Lies in Bobo-Dioulasso District in the west of the country, 80km north of the town of Bobo-Dioulasso (the second largest town in the country). The reserve is roughly oblong about a north-south axis, and lies between the Black Volta River and the Bossora/Bala highway. The Wolo River forms the south-west limit. 11°30'-11°45'N, 04°05'-04°12'W

DATE AND HISTORY OF ESTABLISHMENT The Hippopotamus Pool was gazetted as classified forest on 26 March 1937 by Order No. 836 SE, which also established Bansie, Bambou Kapo and Bahou classified forests. Accepted as a biosphere reserve October 1986.

AREA 19,200ha is classified, although the biosphere reserve nomination only indicates 16,300ha.

LAND TENURE State

ALTITUDE 300-320m

PHYSICAL FEATURES The reserve lies in a flat plain and comprises three geomorphological units, areas which have a hard ferruginous pan or shield close below the surface, those areas where this pan has broken down and mixed with the underlying sands, and alluvial formations and flood plains. The marshy areas are to be found in the north, and along the Black Volta and its tributaries. "Hippopotamus Pool" is the southern part of the reserve has water all year round and covers some 660ha. The forest is divided into two parts by the River Leyssa, which flows west into the Black Volta. The Mare aux Hippopotames flows into the Wolo River, a tributary of the Layessa which joins the Black Volta a further 1km downstream.

CLIMATE The climate is predominately influenced by dry and moist winds originating from the Sahara and South Atlantic, respectively. The dry season lasts for six months, from November to April, and the wet season for 88 days. Mean annual rainfall is 1100mm and mean annual temperature 28°C, at an altitude of 310m.

VEGETATION Generally comprises open forests, rich in species with Guinean affinities, and gallery forests along the water courses. The most common species are Anogeissus leiocarpus, Crataeva adansonii, Nauclea latifolia, Cola cordifolia, Berlinia grandiflora, Detarium microcarpum, Elaeis guineensis, Raphia sudanica, Daniellia oliveri, Hymenocardia acida, Lannea velutina, Parinari polyandra, Albizzia chevalieri and Pterocarpus erinaceus. In drier areas, forest gives way to savanna, with Combretum spp., Isobertlinia doka and grasses, such as Andropogon gayanus. Vegetation in the areas influenced by the iron pan is a mosaic of thickets of various species, and fairly denuded zones. Finally, there are the areas of aquatic vegetation, and those frequently flooded. Floating vegetation in the lake includes Pistia stratioides, Eischnornia natans, and species of Azola,

Neptunia and Ipomea, while on the banks are dense thickets of species such as Ficus congensis and Canthium correllia. Zones which are flooded from time to time include species such as Mitragyna inermis and Crataeva religiosa. Further details of the flora are given by Maldague (1986) and Ministère de l'Environnement (1989).

FAUNA Species density within the reserve is generally low, particularly for mammals. The most important large mammal is hippopotamus Hippopotamus amphibius, of which there were 39 in 1989. Numbers are higher during the wet season. The avifauna includes some 200 species, with diversity particularly high in the lake area. Noteworthy groups are the ardeids, francolins and columbids. Hippopotamus pool is an important breeding and nursery ground for fish such as Tilapia spp. Further details of the fauna are given by Maldague (1986) and Ministère de l'Environnement (1989).

CULTURAL HERITAGE The local people are Bobo, traditionally agriculturalists, together with some Mossi migrants and Peul stock-raisers.

LOCAL HUMAN POPULATION There are five villages (Badema, Bala, Bossora, Paramasso and Sokourani) in close proximity to the reserve with some 22,000 inhabitants. Slash-and-burn agriculture is practised, the main crops cultivated being Pennisetum americanum and Sorghum spp. At Bala, the main activity in the dry season is fishing. Women collect fungi in the wet season. In the south-west of the country, rice is becoming an increasingly important crop and with it the demand for suitable wetland. Thus the status of the reserve as a protected area will become more important. Agricultural activities in surrounding areas were studied by Ministère de l'Environnement (1989).

VISITORS AND VISITOR FACILITIES Some tourists visit the area to watch hippopotamus.

SCIENTIFIC RESEARCH AND FACILITIES In 1978 the CNRST began preliminary studies of the reserve, and a list of research projects is given by Maldague (1986). A three-week study in the reserve by a large number of participants from Burkina and elsewhere resulted in the drawing together of much information, and the incorporation of new material (Ministère de l'Environnement, 1989). The report recommends a programme of research both within the reserve and in surrounding areas.

CONSERVATION MANAGEMENT A management plan is under preparation (Maldague 1986). The system of zonation proposed in the biosphere reserve nomination comprises a core area to the north of Leyessa River, with three buffer zones to the south-east and north-east. The zone proposed for experimental research will contain the Mare aux Hippopotamus. A training/tourist zone has been proposed but its location is unknown. A zone of influence extending beyond the reserve to surrounding villages is planned. Ministère de l'Environnement (1989) identifies the importance of planning fire control methods. It also discusses forest management within the reserve, including small-scale silviculture in three blocks in the eastern part (totalling 2,075ha). Certain forms of fishing are allowed by permit. Ministère de l'Environnement (1989) makes a series of recommendations, based on a three-week study of the area by a large number of participants from both within the country and outside. These include recommendations on extension of the reserve (a possible further 3,650ha), management of the vegetation and fauna, development of tourism, surveillance, and development in surrounding zones.

MANAGEMENT CONSTRAINTS Fire is a particular concern in the forested areas during the dry season. While inadequate staffing is a problem, local people would appear

to respect the reserve boundaries (Ministère de l'Environnement, 1989). However, poaching is a problem which has clearly led to low animal population densities and fire is often deliberately set. It is thought that most of the problems and their effects are reversible.

STAFF There is a forest agent based at Bala, but his duties cover the whole département at Satiri, and not just the reserve.

BUDGET No information

LOCAL ADMINISTRATION IRBET/DGRST, BP 7047, Ouagadougou. There is a guard post at the village of Bala on the edge of the reserve.

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## CANADA - Quebec

NAME Réserve mondiale de la biosphère de Charlevoix

IUCN MANAGEMENT CATEGORY

I (Scientific Reserve)  
IV (Managed Nature Reserve)  
V (Protected Landscape)  
IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 1.04.03 (Canadian Taiga)

GEOGRAPHICAL LOCATION The reserve is situated in Eastern Canada in the Laurentian massif. Its south-eastern border is the middle of the St Lawrence River, the northern boundary extends from the mouth of Saguenay River opposite Tadoussac along this river to Cap Trinité, then inland to include parts of the Parc des Grands-Jardins and Mont Camille-Pouliot to meet the St Lawrence at Sainte-Anne de Beaupré. The core area is centred around the township of La Malbaie, the Haute-Gorges de la Rivière Malbaie and the Parc de conservation des Grands-Jardins (MAB Canada, 1988). The entire reserve is located in the municipalities of Saint-François-Xavier de la Petite Rivière and Saint-Fidèle in the Rive nord de Québec administrative region, over 25km north-east of Quebec City. 47°15'-48°05'N, 69°55'-71°10'W

DATE AND HISTORY OF ESTABLISHMENT The biosphere reserve was designated in November 1988. The principal legislation includes provincial and local administrative regulations. The constituent units include the Parc des Grands-Jardins designated in 1981, originally part of the Parc des Laurentides created in January 1895 by special decree. Hautes-Gorges de la Rivière Malbaie is currently protected under municipal legislation and awaiting approval of provincial or national legislation; Cap Tourmente was established as a national wildlife area under the Federal Wildlife Act of 1973 (IUCN, 1987). General legislation covering the reserve include the Loi sur la protection du territoire agricole of November 1978 enforced at Charlevoix from 1981; the Loi sur les parcs (Québec) adopted in November 1977 applied to Grands-Jardins; the Loi sur les biens culturels of December 1972 and applied to the cultural heritage sites of the reserve (MAB Canada, 1988). The Réserve nationale de la faune of Cap Tourmente was designated as a Ramsar site in 1987 (IUCN, 1987).

AREA 460,000ha (core area 63,400ha; buffer zone 393,600ha; transition zone 643,000ha) (MAB Canada, 1988).

LAND TENURE Principally state or provincial ownership with two main private commercial companies; the rest is public domain or in private ownership (MAB Canada, 1988).

ALTITUDE 0-3,800m

PHYSICAL FEATURES The reserve comprises two main geographical regions, the Charlevoix coast and the Massif des Laurentides. The topography includes undulating hills and mountainous terrain, with dramatic fjords, capes, headlands, bays and bights. The St Lawrence River estuary, orientated in a north-north-east direction dominates the southern boundary, separating two geological units, the Canadian Shield to the north and the Appalachians to the south. The estuary lies along an ancient area of tectonic movement, the Logan Fault. Its waters vary from 10 to 60m in depth, greatest between the mouth of the River Saguenay and Baie-

Saint-Paul. The estuary bed is mainly gravel, sands and clay (MAB Canada, 1987). Turbidity attains 100 nanogrammes/litre and salinity 22/1,000 at Port-au-Saumon (MAB Canada, 1987). Tidal amplitude is 4.1m at mean tides and 5.8m at neap tides, the broad coastal flats like those at Cap Tourmente and Baie-Sainte-Catherine being subjected to heavy tidal flooding (IUCN, 1987; Drucker, pers. obs., 1989). The geology of Charlevoix is characterised by relatively complex rock formations, grouped into five main series; gabbro-anorthosite; charnockite; migmatite; paragneiss/granite; and mainly sedimentary rocks including sandstone, conglomerates, schists and limestone of Ordovician age (MAB Canada, 1988). A significant proportion of the reserve consist of rocks dating from the Precambrian. The main coastal escarpment corresponds to the St Lawrence fault and that of Ile-aux-Coudres to the Appalachian fault. Seismic activity still occurs along the St Lawrence valley, first recorded in 1663, then again in 1771, 1831, 1860, 1870 and 1925. In 1979, a level of 5 to 5.9 on the Richter scale was recorded in the area (Robitaille, 1988).

The landscape of the region has been moulded by two main events in the relatively recent geological past: glacial erosion and deposition and the effects of an impact from an ancient meteorite 350 million years ago (MAB Canada, 1987). Glacial activity occurred in two cycles across 80% of the reserve, leaving moraine deposits such as that at Saint-Narcisse, 'U' shaped valleys, drumlins, kettles, eskers, hanging valleys and waterfalls up to 300m high. At the 'Palissades' are glacial valleys with cliffs 120m high on average and escarpments attaining 300m (MAB 1988). A semi-circular depression near the Massif of Eboulements, descending sharply to Baie-Saint-Paul and the coastal region around La-Malbaie, originated from the impact of a meteorite some 2km in width during the Ordovician period (Robitaille, 1988). The Laurentian massif has the most elevated and extensive mountainous area of the Laurentian zone, its highest summit, Mont Raoul-Blanchard, reaching 1,170m.

The tributary valleys of St Lawrence are a mosaic of fluvio-glacial and marine deposits. Numerous rivers which have their sources in the Laurentians drain into the St Lawrence. The River Malbaie has a drainage basin covering 1,850 sq.km and extending for 150km; the River du Gouffre has a catchment of 1,000 sq.km. and the other main river, River Jean-Noël, only drains an area of 140 sq.km (MAB Canada, 1988). The Laurentians contain well over 1,000 lakes larger than one hectare, 30 over 100ha and 4 over 200ha, the latter including Pikauba (725ha), Malbaie (660ha), Jack (300ha) and Martres (290ha) (MAB Canada, 1988).

**CLIMATE** The region is under the influence of maritime and continental climates and localised microclimates. Overall, the maximum mean temperature in the hottest month is 24°C (July) and the coldest month -14.7°C (January). Whilst the water temperatures of the St Lawrence estuary vary annually from 8°C to 16°C (ice may occur between December to April), air temperatures range from an average of 3.6°C at 45m to 2.5°C at 405m and 0.3°C at 670m. Overall, mean annual precipitation is 1090mm. Total annual precipitation ranges from 840mm at 45m to 1449mm at 670m. Snow forms 50% of the precipitation between December and March. The coastal stations of La-Malbaie and Baie-Saint-Paul record average precipitation levels of 25% less than that at Quebec city (MAB Canada, 1988).

**VEGETATION** There are three distinct vegetation zones at Charlevoix; mountain taiga and tundra on the highest peaks, forested plateaux and valleys and littoral/marine environments. The estuarine tidal marsh and flats are dominated by Scirpus americanus meadows which also include Zizania palustris, Sagittaria cuneata and S. latifolia (IUCN, 1987; Drucker, pers. obs., 1989). Inland along the coast up to an altitude of 300m, are boreal forests of fir Abies spp. and

spruce Picea spp., pine Pinus spp., laurentian maple Acer spp. and sugar maple Acer saccharum. Maple forests also include paper birch Betula papyriferae, alder Alnus spp. and elm Ulmus spp., with an understory layer of sumac Rhus typhina, Acer pensylvanicum, Cornus alterifolia and Lonicera canadensis (MAB Canada, 1988; Drucker, pers. obs., 1989). The herbaceous layer comprises largely numerous gramineae species, Maianthemum canadense, Oxalis montana and Clintonia borealis (Grandtner, 1966; MAB Canada, 1986). The fir zone found at altitudes less than 600m consists of mixed fir Abies spp. associated with numerous shrubs, including Corylus cornuta, Sambucus pubens, Taxus canadensis, Cornus canadensis, Sorbus america and Linnaea borealis (Grandtner, 1966; MAB Canada, 1988).

On the highest summits taiga occurs, giving way to patches of tundra at 950-1100m. Ericaceous zones consist of Kalmia spp., Ledum groenlandicum, Vaccinium spp. and a ground cover of moss. This alpine stage is also represented by a stunted vegetation community (krummholz) with miniature specimens of Picea mariana and Abies balsamea, their growth retarded due to low soil nutrient content and extreme climatic conditions. The trees are interspersed with Ledum groenlandicum and Vaccinium spp. shrubs and lichen layers of Cladina rangiferina, C. mitis and C. alpestris (Grandtner, 1966).

**FAUNA** The St Lawrence River experiences cold currents from Labrador, rich in planktonic euphausiids and copepods, which attract shrimps, fish, whales and many birds. Atlantic salmon Salmo salar has been reintroduced in River du Gouffre. Trout Salmo spp. and eels (Anguilliformes) are common. Capelin is found here at its western limit of distribution. Marine mammals are found in relative abundance, including migrating populations of right whale Eubalaena glacialis, humpback whale Megaptera novaeangliae (E), fin whale Balaenoptera physalus (V), minke B. acutorostrata, blue whale B. musculus (E), and a sedentary population of white whale, beluga Delphinapterus leucas (K), which breeds at the estuary to the Saguenay River, around the Ile-aux-Coudres and off Cap à l'Aigle (Drucker, pers. obs., 1989). Harbour seals Phoca vitulina also breed in the area (Drucker, pers. obs., 1989). The terrestrial fauna is typified by a diversity of forest mammals such as lynx Felis spp. and beaver Castor canadensis, but also includes a small population of caribou Rangifer tarandus.

There is an abundance of wading and wetland birds. Greater snow goose Anser caerulescens atlanticus stops over at Cap Tourmente during migration, as do large numbers of surface-feeding ducks, mainly black duck Anas rubripes, green-winged teal A. crecca carolinensis, blue-winged teal A. discors and pintail A. acuta (Lemieux, 1978; IUCN, 1987).

**CULTURAL HERITAGE** During the second voyage of exploration to Canada by Jacques Cartier in 1535 he surveyed the Charlevoix area and named the Ile-aux-Coudres 'hazel island' (Association touristique régionale de Charlevoix, 1989). As early as the 17th century, the land around River du Gouffre was being colonised, the canton or seigneurie de la Malbaie in 1653, Murray Bay in 1782, Les Eboulements in 1653, Gouffre in 1682 and Ile-aux-Coudres in 1687 (MAB Canada, 1988). Historically, the inhabitants relied upon shipbuilding, forestry, whale and beluga hunting and eel fishing. To this day, the population on Ile-au-Coudres maintains craft-weaving and traditional handicraft techniques. On the coast of Charlevoix, shipyards built more than 300 ships between 1860 and 1959. A current project at La Malbaie is recreating an 18th century ship, the Pelican, using traditional woodworking crafts (Association touristique régionale de Charlevoix, 1989; Drucker, pers. obs., 1989). The forestry industry and traditional lifestyles of the region inspired the literary work of Mgr Felix Antoine-Savard in his novel 'Menaud Maître Draveur' and works by William Blake in the 1890s. The area has

been illustrated in the paintings of Aurele Fortin, Jean-Paul Lemieux and Clarence Gagnon (Robitaille, 1988). A large number of historical monuments are protected, such as the windmills at Saint-Louis de l'Ile-aux-Coudres listed in the early 1960s (Association touristique régionale de Charlevoix, 1989).

**LOCAL HUMAN POPULATION** There is an estimated population of 29,770 spread amongst 21 small municipalities (1988). The most important concentrations are found in the three agglomerations, Baie-Saint-Paul, Clermont and La Malbaie. There are no permanent settlements in the core area, but there are 29,770 people in the buffer zone and another 2,000 in the transition zone (MAB Canada, 1988). The principal sources of employment are tourism, forestry and agriculture. Tourism accounted for 13% of employment in 1976 rising to 23% in 1981, and subsequently has occupied an increasingly dominant place in the economy of the region (MAB Canada, 1988). Agriculture is concentrated in the valleys of the rivers Malbaie and Gouffre where agro-forestry also occurs. Forestry resources still play an important role in the economy, with paper and pulp industries based at Clermont, although the old method of transport by floating logs downriver is dying out (Drucker, pers. obs., 1989).

**VISITORS AND VISITOR FACILITIES** Tourism started as early as 1760 on a small scale (Association touristique régionale de Charlevoix, 1989). To-day, the number of visitors totals approximately 500,000 per year (MAB Canada, 1988). A wide diversity of activities and facilities is available to the visitor. Open air activities include hiking, alpinism, nature interpretation, cross-country skiing, river excursions, nature and whale watching tours, with pleasure boating, canoeing, swimming, sports fishing and hunting (MAB Canada, 1988; Association touristique régionale de Charlevoix, 1989). There is a diversity of facilities ranging from major hotels in the larger towns to farm accommodation and activity centres, a total of well over 1,500 rooms (Robitaille, 1988; Purdie, pers. comm., 1989). There are museums, art galleries, a school of music at Saint-Irenée, a paper handicraft centre, and a ski station is being built at Petite-rivière Saint-François. Information and interpretation centres include those at Haute-Gorge de Rivière Malbaie, the Centre écologique de Port-au-Saumon, and the Centre éducatif forestier 'Des Palissades' near Saint Simeon. The Centre éducatif forestier was established in 1972 and was set up to introduce the public to countryside interpretation. There is an interpretation pavillion, information centre, exhibition room and projection facilities. The Centre écologique de Port-au-Saumon near Saint-Fidèle organises annual 'Festivals of Science and Nature' in collaboration with the Association touristique régionale de Charlevoix. It is also an education centre with 30 or so nature trails, a marine trail and up to 2,000 vacationers per years. At Pointe Noire on the Baie Sainte-Cathérine there is an observation tower and beluga interpretation centre run jointly by the Société linnéenne du Québec and Parcs Canada (Drucker, pers. obs., 1989). The Centre d'histoire naturelle de Charlevoix is located at Baie-Saint-Paul (Association touristique régionale de Charlevoix, 1989).

**SCIENTIFIC RESEARCH AND FACILITIES** In 1988 there were 50 national scientists and 10 foreign participants undertaking studies at Charlevoix (MAB Canada, 1988). The wide range of scientific projects includes studies of problems affecting the ecosystem, long-term ecological surveillance, work on soil utilisation, vegetation mapping, aquatic brackish water and marine hydrology, limnology and water quality, atmospheric pollution, inventories of fish, mammals, invertebrates and vascular vegetation along with geomorphology, geology, soil ethnobiology, seismology and countryside architecture (MAB Canada, 1988). In addition to a station for the study of atmospheric pollution and climate, there are also conference facilities, hydrological stations, laboratories and libraries. Currently studies are being

carried out at the Centre écologique de Port-au-Saumon, which also has education facilities, lodgings, a library, marine laboratories and boats. The Canadian Wildlife Service maintains facilities including a library, observatory and museum at Cap Tourmente, where research has been carried out since the mid-1950s on the snow goose and its habitats (IUCN, 1987). Other early studies in Charlevoix include those on the reintroduction of caribou from 1965 to 1972. Research in the Forêt Montmorency includes studies on silviculture, climatology and forestry exploitation undertaken by the Université Laval de Québec. In the 1960s, the Canadian National Film Board produced a documentary by P. Perreault about life on Ile-aux-Coudres (Association touristique régionale de Charlevoix, 1989).

**CONSERVATION VALUE** The reserve was established primarily to integrate natural landscapes and wildlife with the development of rural agriculture, local participation and education. The Hautes-Gorges de la Rivière Malbaie is the deepest gorge in eastern Canada, being 1,050m deep, and the region is of importance for its well documented and unique geological features and for the diversity of its fauna and flora, including an internationally important wetland, a population of internationally threatened whales and of regionally threatened ecosystems including Scirpus marsh.

**CONSERVATION MANAGEMENT** The management infrastructure for the biosphere reserve has not yet been completed. However, there are currently five distinct administrative zones corresponding to the five central areas; the Parc des Grands-Jardins, Hautes-Gorges de la Rivière Malbaie, Centre écologique de Port-au-Saumon, Forêt Montmorency, and the Centre éducatif forestier 'Des Palissades'. The first is under the jurisdiction of the provincial Ministère du loisir, de la chasse et de la pêche; 'Des Palissades' and Hautes Gorges under the provincial Ministère de l'énergie et des ressources (the latter area administered by the Association de développement des Hautes-Gorges de la Rivière Malbaie). The Centre écologique is owned and managed by a private corporation and the Forêt Montmorency by the Université Laval de Québec. Cap Tourmente National Wildlife Area is administered by the Quebec region of the Canadian Wildlife Service (IUCN, 1987).

All public forests within the reserve come under the jurisdiction of the provincial Ministère de l'énergie et des ressources. The Ministère de l'agriculture, des pêche, et de l'alimentation du Québec controls agriculture and fisheries, whilst the Ministère de l'environnement du Québec is involved in monitoring pollution and the quality of the environment. The federal Fisheries and Oceans Canada has produced a series of guidelines and protection regulations prohibiting the hunting and willful disturbance of whales in the region (Pêches et Océans Canada, 1989). The main managed protected areas at present are divided into three zones, core, buffer and transitional. Each zone has been established to control activities, ensure nature protection, education and recreation. Permitted activities in specified zones are wide and diverse, ranging from agriculture and forestry to livestock rearing, hunting and fishing, tourism and house construction. Permits are required for hunting and fishing wildlife within the core protected areas.

Pollution is a major threat to Charlevoix and the St Lawrence region as a whole. The federal government established its St Lawrence Action Plan in 1988, which proposes that by 1993 there ought to be a reduction by 90% of the liquid toxic waste discharged into the St Lawrence River. Also, as part of this plan the federal government intends to spend \$5 million to buy areas of wildlife habitat, including sites in Charlevoix, which will then be turned over to non profit-making citizen's groups. The Quebec government has undertaken its own plan to make the 630 worst polluters in the province cut their emissions by 75% within the next 10



years. In the 1989 Quebec election campaign the Liberal leader announced the creation of a new provincial government body, the St Lawrence Development Agency, to oversee the spending of more than \$6 million to reduce pollution throughout the St Lawrence region (Drucker and Fisher, 1989). The Haute Gorges de la Rivière Malbaie is a proposed park and the estuary of the Saguenay River a proposed national marine park (Ministère du loisir, de la chasse et de la pêche, n.d.).

MANAGEMENT CONSTRAINTS In the past there was excessive felling of forests and hunting, which in part led to the decline and eventual extinction of the local caribou population. The greatest threat to the marine and terrestrial zones are pollution, both water pollutants and atmospheric precipitation (Picard, 1989; Drucker and Fisher, 1989). The Gouffre and Malbaie river sediments have high accumulations of pollutants and in the St Lawrence there are extremely high levels of heavy metals, organochlorines and polychlorinated biphenyls (PCBs). Dead beluga washed up near Saguenay show recorded PCB levels which are 800 times greater than that believed safe in humans, and shellfish have been affected by bacteriological contamination at Baie-Saint-Paul and La Malbaie as a result of sewage effluent (Picard, 1989). There are an estimated 2,300 companies causing pollution of the St Lawrence river (Drucker and Fisher, 1989). Lack of coordination between the various provincial and national authorities administering the biosphere reserve may well cause future management difficulties (Drucker, pers. obs., 1989).

STAFF Yet to be determined

BUDGET Medium-term proposed annual budget of \$100,000 (MAB Canada, 1988)

LOCAL ADDRESSES Corporation de la réserve mondiale de la biosphère de Charlevoix, 166 boulevard de Comporté, Case Postale 417, La Malbaie GOT 1JO, Québec

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## CANADA - Ontario

**NAME** Niagara Escarpment Biosphere Reserve  
(includes the 105 parks within the Niagara Escarpment Parks System)

**IUCN MANAGEMENT CATEGORY**

- I (Strict Nature Reserve)
- III (Natural Monument)
- IV (Managed Nature Reserve)
- V (Protected Landscape)
- IX (Biosphere Reserves)

**BIOGEOGRAPHICAL PROVINCE** 1.05.05 (Eastern forest)

**GEOGRAPHICAL LOCATION** Located in southern Ontario, stretching approximately 725km from Queenston, on the Niagara River, to the islands off the tip of the Bruce Peninsula. Major towns along its route include those of Niagara Falls, St Catharines, Hamilton, Owen Sound, Warton and Tobermory. Hamilton is located 38km from the nearest boundary of the biosphere reserve. 43°10'-45°15'N, 79°03'-81°40'W

**DATE AND HISTORY OF ESTABLISHMENT** Protected under national and provincial legislation. Main documentation includes the Niagara Escarpment Planning and Development Act of 1973 (revised statutes of Ontario, 1980, Chapter 316, amended in 1981, Chapter 19, Section 14). With the passage of this Act in 1973, the Ontario Provincial Government established a planning process to ensure that the area would be protected. A final Niagara Escarpment Plan was approved by Cabinet in June 1985 which provides a framework of objectives and policies aimed at striking a balance between development, preservation and enjoyment of the escarpment. Approved by the Unesco MAB Committee as a biosphere reserve in February 1990.

**AREA** 207,240ha, with a core area of 26,300ha, a buffer zone of 93,340ha and a transition area of 87,600ha

The area encompassed by the Niagara Escarpment Plan is approximately 190,300ha and there are 105 parks of varying sizes located along its length (the ten main 'nodal' protected areas being Cyprus Lake Provincial Park, Skinner's Bluff Conservation Area, Inglis Falls Conservation Area, Walters Falls Conservation Area, Pretty River Valley, Mono Cliffs Provincial Park, Terra Cotta Conservation Authority, Crawford Lake/Rattlesnake Point Conservation Area, Dundas Valley Conservation Area and Short Hills Provincial Park).

The area of Bruce Peninsula National Park (13,028ha), outside the plan area, is about 5,400ha. The area of Fathom Five National Marine Park lying outside of the plan area is 11,540ha. Some land is still being acquired and the long-term goal of the Niagara Escarpment Land Acquisition Program is the completion of a 51,093ha parks system along the length of the Niagara Escarpment.

**LAND TENURE** Land tenure is mixed, involving federal, provincial, municipal and private ownership. Lands owned by eight counties or regions and 36 local municipalities are affected by Plan policies. The area includes parkland owned by the Ministry of Natural Resources, seven watershed conservation authorities, and several other public bodies.

**ALTITUDE** Ranges from 109m in the Hamilton area to approximately 560m in the

Collingwood area. Maximum depth is 90m below sea-level in the national marine park.

**PHYSICAL FEATURES** The escarpment is the outer rim of an ancient lake bed known as the Michigan Basin. These massive topographic features date back some 430 to 450 million years (McKibbin *et al.*, 1987; Niagara Escarpment Commission, 1990). It is partially exposed as a fossil rich sedimentary bedrock formation, substantially moulded by glacial processes during the Pleistocene. In southern Ontario it rises to a maximum of 560m and extends 725km. Topographic features along the escarpment include high cliffs, deep valleys, scenic waterfalls, karst formation, caves, rugged hills and rolling glacial formations. The bedrock is composed of many different rock formations, resulting in the escarpment face having a terraced appearance due to differential rates of erosion. In many places along its length, the rock is obscured or completely buried by glacial materials (Anon., 1989). Soils are derived from glacial till and glacial meltwater erosion processes. They are mainly varying mixes of sand, gravel, clay and loam. The reserve includes the headwater drainage from seven watersheds which flow to the Great Lakes. Up to 15 small waterfalls occur along the escarpment. The Niagara Falls, 11km upstream of the escarpment, plummet 55m into the Niagara Gorge formed by post-glacial erosion of the Niagara River channel (NEC, 1990a).

**CLIMATE** Temperatures range from -35°C in January to the occasional 36°C in July and August. Maximum average temperature of the warmest month is 23.4°C and minimum average temperature of the coldest month is -13.5°C. Rainfall varies along the length of the escarpment but ranges generally from 700mm to 1000mm per year, averaging at 963.7mm at elevations of 415m. Annual snowfall ranges between 100cm and 300cm and represents approximately 34% of total precipitation.

**VEGETATION** The escarpment runs through two forest regions: the deciduous (or Carolinian) and the Great Lakes - St Lawrence. The trees are primarily deciduous, although conifers occur in places. Flora includes over 100 species and varieties of special interest including 58 species of bryophyte, 49 species of fern and 37 species of orchid (Anon., 1989). In Grey County alone a recent study listed 433 plant species in an area of 451ha (Anon., 1989). Characteristic communities include mixed forest dominated by sugar maple *Acer saccharum*, red maple *A. rubrum*, beech *Fagus grandifolia*, red oak *Quercus rubra*, white oak *Q. alba*, ash *Fraxinus americana*, linden *Tilia americana*, pine *Pinus strobus*, *P. resinosa*, hemlock *Tsuga canadensis* and spruce *Picea glauca* (Anon, 1989). Escarpment rim woodland includes arbor-vitae *Thuja occidentalis*, birch *Betula papyrifera* along with a number of other mixed forest species (Anon, 1989). Rich communities of ferns and bryophytes are found on and among exposed rock, crevices and talus slopes. On lake shores, the vegetation is typified by arbor-vitae *Thuja occidentalis*, willow *Salix* spp, *Physocarpus opulifolius* and *Potentilla fruticosa*, whilst shallow lake vegetation is represented by willow *Salix* spp., *Cornus* spp, *Scirpus* spp, *Typha latifolia*, *Nuphar odorata*, *N. variegatum*, *Potamogeton* spp, *Pontederia cordata* and *Carex* spp (Anon, 1989). Bog complexes are composed of *Larix laricina*, *Thuja occidentalis*, *Rhamnus alnifolius*, *Myrica gale*, *Rosa palustris* and *Sphagnum* spp (Anon, 1989).

Communities of particular interest include those in the section between Guelph and Niagara Falls, where there are seven remnant sections of the Carolinian vegetation zone, one of the most threatened regions of Canada. Notable species include tulip tree *Liriodendron tulipifera*, sassafras *Sassafras albidum*, black oak *Quercus velutina* and blue beech *Carpinus caroliniana*, all species close to the northern limits of their distribution. Nationally and provincially threatened plant species include *Carex appalachica* and *Panax quinquefolius* (Anon., 1989).

**FAUNA** Over 162 nesting birds have been recorded, 53 mammal species, 36 reptile and amphibian species and 70-90 fish species (Anon., 1989). Common mammal species include white-tailed deer Odocoileus virginianus, beaver Castor canadensis, mink Mustela vison, otter Lutra canadensis, porcupine Erethizon dorsatum, raccoon Procyon lotor, fox Vulpes vulpes, and chipmunk Tamias sp. Less frequent are black bear Ursus americanus, lynx Lynx lynx, weasel Mustela frenata and coyote Canis latrans. Bat colonies are found in the limestone cliffs and caves. Numerous bird species are found along the length of the escarpment. "Forest interior" species include tufted titmouse Parus bicolor, northern mockingbird Mimus polyglottus and Louisiana waterthroat Seiurus motacilla (Anon., 1989). Several species of snakes are found. The locally threatened Eastern Massassauga rattlesnake Sistrurus catenatus is the only poisonous one, and is most frequently found on Bruce Peninsula (Anon., 1989).

**CULTURAL HERITAGE** The region has long been settled by man. Evidence of a 500-year old Iroquoian Indian village exists at Crawford Lake Conservation Area. Cape Croker Indian Reserve was established in the early 1800s by the Ojibwa Indians (Hamilton Area - Niagara Escarpment Explorer, 1988; NEC, 1990b). Evidence of settlement by British colonists is provided by numerous surviving "ghost towns" along the length of the escarpment. The area became important for the establishment of late 18th century British military outposts during the campaigns for control of the peninsula in the Anglo-American war of 1812-1814. Stoney Creek Park is the site of a battle where British troops repelled American forces on 6 June 1813. Nearby Fort George has been reconstructed to represent early 19th century British military life. A monument to General Brock is located at Queenston Heights. Other notable historic features include the old Welland Canal.

**LOCAL HUMAN POPULATION** A great number of villages, towns, and cities are situated along and within close proximity of the escarpment. Land use is a mosaic, ranging from fruit growing and tourism, to agriculture and beef production. The number of residents within plan area was calculated to be 117,654 using 1986 census data (Anon., 1989). The total population encompassing the whole area is 3 million, the largest city being Hamilton with a population of 307,000 (NEC, 1989). The Saugeen-Ojibway Indians own Cape Croker Indian Reserve and other special hunting grounds on Bruce Peninsula, all immediately adjacent to the biosphere reserve. The reserve has a settlement of some 600 Ojibwa (the Chippewas of the Nawash band) natives (Anon., 1989; NEC, 1990b).

**VISITORS AND VISITOR FACILITIES** The entire Niagara Escarpment offers outstanding and varied tourist potential. Numerous parks along the escarpment provide many opportunities for recreation, activities ranging from wind surfing, to skiing, nature study, swimming, fishing, hang gliding, camping and hiking. Bruce Trail is an hiking trail of over 740km in length, extending along the escarpment from Queenston to Tobermory. The trail links the natural features and parks of the Niagara Escarpment Parks System (NEC, 1990b). Many of the parks offer interpretive programmes. No precise figures are available for the numbers of visitors to the entire region, although an estimated 300,000 people visit the upper Bruce Peninsula each year, and as many as 84,000 divers were registered at Fathom Five National Marine Park in 1988 (NEC, 1990b). Nearby Niagara Falls is one of the world's top tourist destinations, attracting an estimated 11 million visitors a year (NEC, 1990b).

**SCIENTIFIC RESEARCH AND FACILITIES** Extensive research has long been undertaken throughout the region, including studies by three universities located within or adjacent to the escarpment corridor. These are Brock, McMaster and Guelph universities. In total, six Ontario universities are within two hours travel time

to portions of the escarpment, permitting excellent field research capabilities. A feasibility study is underway to establish a joint university-government field station at Emmett lake within the planning area on Bruce Peninsula (Anon., 1989). Annual government field surveys are made of environmentally sensitive areas by the Ontario Ministry of Natural Resources and various conservation authorities within the corridor. Following field assessment surveys, the Ministry of Natural Resources has identified 91 "areas of natural and scientific interest" within the plan area (NEC, 1990b).

Research activities include work on acidic deposition, agriculture, biological surveys of flora and fauna, cultural anthropology, ecological succession, ecosystem restoration, effects of atmospheric pollutants, effects of Great Lakes level changes, effects of water pollutants, fire history and effects, fish population dynamics, forest ecology, limnology, mining reclamation, recreation/tourism impacts, resource mapping, social sciences, soil conservation, watershed research, wildlife population dynamics and "viewshed analyses" of the visual/aesthetic impacts of proposed developments (Anon, 1989). Research facilities include conference/meeting rooms, hydrological monitoring equipment, libraries, research vehicles, permanent monitoring plots for vegetation, along with major governmental laboratories for environmental sciences and resource management, based in Toronto, and the Canada Centre for Inland Waters in Hamilton (Burlington). The Royal Botanical Gardens is located in Burlington and includes display gardens, teaching and research facilities and an arboretum.

Within the reserve there are also environmental educational facilities for school children, interpretative programmes for tourists and professional training workshops for resource managers and planners. About 20 schools and outdoor centres are located in the Niagara Escarpment Commission planning area, offering formal outdoor education programmes.

CONSERVATION VALUE The escarpment bisects the southern portion of Ontario province, creating an unique geological and ecological landscape. The species richness of the area is exemplified by plants with Arctic and boreal affinities. There are many plant and animal species at the northern limit of their range, conversely species at the southern edge of their breeding range may be found. The oldest of the forest trees are eastern white cedars which have been dated at 723 years, the oldest living trees in Ontario (NEC, 1989).

CONSERVATION MANAGEMENT Recognising the natural and cultural treasure of the region, the Ontario government devised the Niagara Escarpment Planning and Development Act (1973) which led to the creation of the Niagara Escarpment Plan of 1985, Canada's first large-scale environmental land use plan. The plan has three components: land use policies, development criteria and the Niagara Escarpment parks system. The System provides a framework for establishing and coordinating 105 existing and proposed parks within an unified system. It is organised and managed cooperatively by seven conservation authorities, the Ministry of Natural Resources, and other municipal and governmental agencies with parkland along the escarpment (McKibbin *et al.*, 1987). The purpose of the Niagara Escarpment Planning and Development Act is "to provide for the maintenance of the Niagara Escarpment and land in its vicinity substantially as a continuous natural environment, and to ensure only such developments occurs as is compatible with that natural environment". To undertake this the NEC ensures development control - a flexible system of land-use regulation which replaces municipal zoning by-laws. Development control is designed to ensure that development in the Niagara Escarpment area is compatible with the natural environment (NEC, 1990b). Specific objectives are: to protect unique ecological and historical areas; to maintain and

enhance the quality and character of natural streams and water supplies; to provide adequate opportunities for outdoor recreation; to maintain and enhance the open landscape character of the escarpment in so far as possible, by such means as compatible farming or forestry and by preserving the natural scenery; to ensure that all new development is compatible with the purpose of the Act; to provide for adequate public access to the escarpment and to support municipalities within the planning area in exercise of the planning functions conferred upon them by the act (Anon., 1989).

Although the escarpment is a continuous and cohesive landform, the features of the peninsula are variable. In order to reflect these differences, the escarpment has been divided into ten segments, each incorporating unique recreational activities, flora and fauna, landforms and cultural features. Each section has been assigned a principal or "nodal" park. The area of the Niagara Escarpment Plan has been divided into seven land use designations: Escarpment Natural Area, Escarpment Protection Area, Escarpment Rural Areas, Minor Urban Centre, Urban Area, Escarpment Recreation Area and Mineral Resources Area. Each designation sets forth specific objectives, criteria for designation, permitted use, and other relevant information (McKibbin *et al.*). Other specific management plans include the Interim Management Guidelines for Bruce Peninsula National Park and Fathom Five National Marine Park (both plans being effective from July 1988).

The 17-member Niagara Escarpment Commission was established under the Niagara Escarpment Planning and Development Act, with its main purpose to provide for the maintenance of the Niagara Escarpment and land in its vicinity. The NEC itself embodies a degree of local participation through its membership structure. The private landowner "stewardship program" and the "Niagara Escarpment Development Achievement Awards" serve to involve local property owners positively in contributing towards the objectives of the plan. Three organisations serve to broaden the base of support for the plan and its objectives. The "Coalition on the Niagara Escarpment" was organised in 1978 to mobilise support for the plan and speaks out as a "watchdog" group to lobby government whenever it deems this necessary. The Bruce Trail Association, with a membership of 7,500, has a central role in maintaining the 737km hiking trail which links the Niagara Escarpment Parks System, and also serves as a central focus for many recreative activities.

MANAGEMENT CONSTRAINTS The Niagara Escarpment Plan arose in response to increasing threats to the natural environment. Primary concerns included aggregate mining and increasing urbanisation. These and other land uses are now controlled more effectively. The southern end of the escarpment passes close to the most intensively urbanised area of Canada, the Toronto-Hamilton-St Catharine's megalopolis, with resulting development pressures. Major pressures continue for residential, resort, and recreational facilities, including condominiums, marinas and ski slopes. Resource extraction continues to threaten the region. Limestone quarries, sand and gravel pits are limited to areas established prior to the plan, although there are some pressures to expand these operations. Forestry operations are maintained in a number of areas (Anon., 1989; NEC, 1990b).

STAFF The commission and its staff are responsible for promoting the objectives set forth in the plan. The commission itself consists of 17 members: a chairman, eight members representing the general public, and eight members who are either members or employees of county or regional councils of the escarpment area. The commission staff numbers 23, and is comprised of a director, three managers, planners, planning technicians, a landscape architect, cartographers, an information assistant, and administration and support staff (Anon., 1989).

BUDGET The annual budget of the commission is Cdn. \$2.5 million (Anon., 1989). Cdn. \$2.5 million have been committed annually for land acquisition for a period of 10 years. Other implementing authorities have an annual budget of \$700,000 allocated to escarpment plan implementation work (Anon., 1989).

LOCAL ADDRESSES Niagara Escarpment Commission, 232 Guelph Street, Georgetown, Ontario, L7G 4B1 (Tel (416) 877-5191)

LIST OF PROTECTED AREAS WITHIN THE BIOSPHERE RESERVE

Sites are listed by the Ministry of Municipal Affairs (1985) and include the following:

Tobermory Islands	Fathom Five	Little Cove
Cabot head	Cape Chin	Smokey Head-White Bluff
Lion's Head	Hope Bat Forest	Colpoy's Bluff
Spirit Rock	Bruce's Caves	Colpoy Lookout
Skinner's Bluff	Slough of Desmond	Kemble Mount
Gowan Lake	Lindenwood	Indian Creek
The Glen	Keppel Forest	Indian Falls
Brookholm	Pottawatomi	West rocks
Inglis falls	East Rocks	Sydenham Forest
Batfield Escarpment	Bognor Marsh	Spey River
Walters Falls	Rocklyn Creek	Griersville
Fairmount	Epping lookout	Robson Lakes
Beaverdale Forest	Wodehouse Creek	Beaver valley lowlands
Old Baldy	Wodehouse Karst	Hogg's Falls
Eugenia Falls	Duncan Crevice Caves	Kolapore Uplands
Loree	Craigleith	Petun
Pretty River valley	Rob Roy Forest	Nottawasaga Lookout
Devil's Glen	Nottawasaga Bluff	Lavender Falls
Pine River	Boyne Valley	Mono Cliffs
Scott's Falls	Humber Valley	Mono Mills Lowlands
Glen Haffy	Sligo Hill	Forks of the Credit
Belfountain	Terra Cotta Forest	Terra Cotta
Silver Creek	Scotsdale Farm	Limehouse
Speyside	Tirion Tract	Esquesing and Escarpment
Hilton Falls	Kelso	Ontario agriculture
Crawford Lake	Crawford Forestry Tract	Yaremko-Ridley
Mount Nemo	Lake Medad	Spencer Gorge
Crook's Hollow	Christie	Summit Bog Muskeg
Dundas Valley	Tiffany Falls	Mount Albion
Felker's Falls	Stoney Creek Battlefield	Devil's Punch Bowl
Vinemount	Winona	Woolverton
Beamer Memorial	Mountainview	Cave Springs
Ball's Falls	Louth	Rockway
St. John's	Short Hills	Welland Canal
Woodend/Queenston Heights		

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## CHINA - Guizhou Province

NAME Fanjingshan Mountain (Mount Fanjing Nature Reserve)

IUCN MANAGEMENT CATEGORY IV (Managed Nature Reserve)  
IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 2.01.02 (Chinese Subtropical Forest)

GEOGRAPHICAL LOCATION Situated in the north-east of Guizhou Province, Fanjingshan Mountain is the main peak of the Wuling Mountain range. The site is about 20 miles from the town of Tongren, and includes parts of three counties: Yengjiang, Shontao and Jiangkon. 27°49'-28°1'N, 108°45'-108°48'E

DATE AND HISTORY OF ESTABLISHMENT The reserve was established in 1978, under the administrative regulations laid down by the People's Government Department of Guizhou Province in Government Paper No.(84)78, whilst administrative measures concerning forest and wild animals were announced by the State Council in 1985. Legal protection is also covered by the legislation of Tongren Prefecture, Guizhou Province, with specific laws and regulations laid down on 12 February 1979 (Anon, 1985). Accepted by Unesco as a biosphere reserve in October 1986.

AREA 41,533ha, including 26,667ha core area

LAND TENURE Tongren Prefecture and People's Government Department of Guizhou Province

ALTITUDE 480-2,570m

PHYSICAL FEATURES The mountain area is part of a large, ancient anticline formed during the Fanjingshan tectonic movement, which lasted 1.4 billion years. This produced a diverse natural landscape with deep gorges and rock outcrops. The rock is slightly metamorphosed Proterozoic Erathem. Fanjingshan Mountain is the watershed for the Yuanjain and Wujang rivers. There are nine main streams cutting into the canyon bottom with a radial drainage system coming down from the peak (Fenglin, 1982; Mingde 1982). Soil types vary with altitude, five types have been described: mountain yellow-red earth (below 500m), mountain yellow earth (between 500-1,400m), mountain yellow-brown earth (between 1,400-2,000m), dark mountain thicket soil (between 2,000-2,200m) and mountain shrubbery-meadow soil (between above 2,200m) (Fenghai and Ming 1982).

CLIMATE At an altitude of 1,200m mean annual temperature is 12.2°C and mean annual rainfall is 2535mm (undated figures from Anon., 1985). A temperature inversion level is often observed between 1,300-1,900 m. Vertical climatic zones have been classified into middle subtropical, north subtropical, south temperate and middle temperate. The south-east and north-east slopes have a lower temperature range and heavier rainfall than the contrasting south-west and north-west slopes (Zongde, 1982).

VEGETATION The mountainous site, with its wide range in altitude, supports a diverse flora. To date approximately 3,000 species have been identified (Anon., 1985). Forests cover 80% of the reserve area, with hardwood species comprising 89% of these (Shiyi and Yunfan, 1982). Five zones of vegetation have been described (Weilian *et al.*, 1982; Wenhua and Xianying, 1989). Evergreen broadleaf forest is found up to 1,300m, dominated by species which include chinquapin

Castanopsis chunii, tanbark oak Lithocarpus spp., cinnamon, machilus, nanmu, manglietia and guger; areas of artificially cultivated Chinese fir forests and Masson pine forests are also found in this zone. Mixed evergreen-deciduous broadleaf forest is found between 1,300-1,900m, with evergreen species such as Steward oak Quercus stewardii, Engler oak Q. engleriana, and sharp-dent oak Cyclobalanopsis oxyodon. These, and other species from the lower zone, grow alongside deciduous species, notably Engler beech Fagus engleriana, Chinese maple Acer sinense, Wilson maple Acer wilsonii, storax Stryax spp., field laquer tree Toxicodendron succedaneum, beautiful sweet gum Liquidambar formosana, katsura tree Cercidiphyllum japonicum var. sinense, and tetracentron Tetracentron sinense. Deciduous broadleaf forest is found between 1,900-2,100m, dominated by some of the deciduous species already mentioned, along with flabellate-leaf maple Acer flabellatum, Keissler mountain ash Sorbus keissleri and oriental photina Photina villosa; shrubs and herbaceous plants also become important in this zone - shrubs such as thick-leaf new litse Neolitsea sp., Guizhou spiraea Spiraea sp., Mary rhododendron Rhododendron mariae, Guizhou rhododendron, Japanese blueberry Vaccinium japonicum, pungent litse Litsea pungens, and Chung China cane Sinarundinaria chungii are all common, herbaceous plants such as false hellebore Veratrum nigrum, needle spike sedge Eleocharis acicularis, Oplismenus compositus, Crawfordia spp. and galingale Cyperus spp. are also common. In the subalpine coniferous zone, from 2,100-2,350m, the climate and soils become increasingly unsuitable for broadleaved trees, which are replaced by tracts of Chinese hemlock Tsuga chinensis and Faber fir. Above 2,350m, there is the subalpine shrub and meadow zone, dominated by rhododendron Rhododendron spp. and Chung China cane Sinarundinaria chungii (Wenhua and Xianying, 1989). A comprehensive list of forest trees from the reserve (406 species) is given in Youyuan and Yeqin (1982). Jiaming and Peiyu (1982) provide a list of 413 flowering plants and ferns, and describe their medicinal value.

A total of 151 species of fungi has been identified (Shaochang, 1982). The reserve also contains some important representatives of ancient flora, for example Mount Fanjing fir Abies fanjingshanensis, silver fir Cathaya argyrophylla, Chinese hemlock Tsuga chinensis, Maire yew Taxus chinensis var. mairei, maidenhair tree Ginkgo bilboa, Chinese tulip tree Liriodendron chinense and also dove tree Davidia involucrata, which grows in some large tracts between 1,000 and 1,800m (Wenhua and Xianying, 1989 and Gengtao, 1985).

**FAUNA** The dominant faunal species present are from the Oriental Realm, although many from the subtropics are also represented. Sixty species and subspecies of mammals have been identified including 13 species that are considered rare in China. Species include Guizhou snub-nosed monkey (golden monkey) Rhinopithecus brelichi (E), south China tiger Panthera tigris (E), Assam macaque Macaca assamensis, rhesus macaque Macaca mulatta, forest musk deer Moschus berezovskii, tufted deer Elaphodus cephalophus and mainland serow Capricornis sumatraensis. The avifauna includes 128 species of breeding birds, of these 95 are resident and 33 are summer visitors (listed in Zhikang, 1982). Of these, four species are not common, Chinese tragopan Tragopan temminckii, mandarin Aix galericulata, Reeves' pheasant Syrnaticus reevesi (K) and golden pheasant Chrylophus picus. The reserve's herpetofauna belongs to the Oriental Realm; 40 species and subspecies of reptiles are present belonging to 24 genera, two of these have been described as native to the area. There are 34 species and sub-species of amphibian belonging to ten genera. Three of these are native to the area and nine are of economic value including the frog Microhyla mixtura and giant salamander Andrias (Megalobatrachus) davidianus (I). A list of these reptiles and amphibians is provided in Dejun (1982).

CULTURAL HERITAGE As a cultural site Mount Fanjing was most important during the Ming Dynasty (1368-1644) when a number of Buddhist temples were built, and the site was a major centre for pilgrimage. Ruins of these temples remain on mountain tops. The mountain was given its present name in the Wanli reign (1573-1620), Mount Fanjing meaning 'mountain of Buddhism and purity' (Wenhua and Xianying, 1989.)

LOCAL HUMAN POPULATION A few villages lie within the site. Activities include agriculture and forestry, with some plantations of Chinese fir and Masson pine in the lowest vegetation zone (Wenhua and Xianying, 1989).

VISITORS AND VISITOR FACILITIES Fanjingshan Mountain is now one of south-west China's major tourist attractions (numbers unknown). Provisions are being made for a special tourist zone within the reserve (Wenhua and Xianying, 1989).

SCIENTIFIC RESEARCH AND FACILITIES Scientific interest in the area dates back to the beginning of the century. A scientific survey was conducted in 1982. Facilities include research and field stations and experimental plots. Medicinal plants have been the subject of several studies over a number of years.

CONSERVATION VALUE Quite apart from the landscape value of the gorges, the reserve supports a substantial variety of flora, and is an important refuge for many ancient species that originated in the Cretaceous or Tertiary, and saw their peak growth two to seventy million years ago. Areas of ancient dove tree Davidia involucrata forest in the core areas are of particular interest. The fauna is diverse and includes several locally rare species. The whole area is remarkably free from pollution (Wenhua and Xianying, 1989.)

CONSERVATION MANAGEMENT A management plan exists and the Management Office of Fanjingshan Mountain is responsible for its implementation. The system of zonation consists of core areas totalling 26,667ha, in which any form of disturbance is prohibited, a buffer zone of 14,466ha and a tourist belt of 4,000ha (Anon., 1985.)

MANAGEMENT CONSTRAINTS No information

STAFF Eighty two, including forty-two administrative staff, three of whom are university-trained. Research staff include five university-trained staff and ten technicians (Anon., 1985.)

BUDGET No information

LOCAL ADDRESSES Management Office, Fangjingshan Mountain Reservation, Shaixinglu, 100, Jiankon, Guizhou

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## CHINA - Fujian Province

NAME Fujian Wuyishan Nature Reserve (Wuyi Mountains Nature Reserve)

IUCN MANAGEMENT CATEGORY IV (Managed Nature Reserve)  
IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 2.01.02 (Chinese Subtropical Forest)/2.15.05 (Oriental Deciduous Forest)

GEOGRAPHICAL LOCATION Situated in the north-west of Fujian Province. Towns near the area include Chonjan and Xingtian, both about 10km to the east, Zhaili and Guangze, both about 5km to the west, and Shaouru about 15km to the south. 27°35'–27°55'N, 117°24'–117°51'E

DATE AND HISTORY OF ESTABLISHMENT Wuyishan Nature Reserve was ratified by the provincial government in April 1979. It was also ratified as a national key nature reserve by State Council in July 1979 and accepted by Unesco as a biosphere reserve in March 1987.

AREA 56,527ha, made up of a core zone of 35,357ha and an experimental zone of 21,180ha.

LAND TENURE State

ALTITUDE 200–2,158m

PHYSICAL FEATURES Movement of the earth's crust has led to the originally continuous mountain chain being bisected by a series of exceedingly deep (up to 1,700m) and steeply sloping (general slope 40°) rift valleys. The highest point in the site is Mount Huanggang. The geology of the area consists of granite and volcanic rock. This area escaped glacial cover and this, coupled with the great complexity of the terrain, has given rise to a wide spectrum of ecosystems and habitats within the area (Wenhua and Xianying, 1989).

CLIMATE The site has the lowest temperatures and the highest precipitation in Fujian Province. Annual temperature ranges from 12° to 18° and annual precipitation ranges from 1400–2100mm. Humidity is high (relative humidity 80–85%) and fog is common (Anon., 1986).

VEGETATION Lying as it does on the transitional belt between the Holarctic region to the north and the Palaeotropical region to the south, the site represents the southernmost haunt of wormwood *Artemisia*, yarrow *Achillea*, pearl everlasting *Anaphalis*, and Tartarian aster *Aster tartaricus*. A number of ancient tropical families are also found, including Sapotaceae, Palmae, Zingiberaceae and Musaceae. The reserve contains the largest sub-tropical broadleaf evergreen forests in China. These are largely found on the lower slopes below 1,100m, and are dominated by the beech family Fagaceae, notably Eyer chinquapin *Castanopsis everi*, Faber chinquapin *C. fabri*, farges chinquapin *C. fargesii*, Hance tanbark oak *Lithocarpus hancei* and blue Japanese oak *Cyclobalanopsis glauca*; other dominant species include red nanmu *Machilus thunbergii*, great spice bush *Lindera megaphylla* and common new litse *Neolitsea aurata*. The tea and magnolia families dominate the sub-canopy tree species, notably Chinese stewartia *Stewartia sinensis*, *Michelia maudiae*, guger tree *Schima* sp., thick-leaf adinandra *Adidandra* sp. and Wuyi manglieta *Manglietia* sp. There is also a well-developed brush layer. Between

1,100m and 1,700m a mixed coniferous-deciduous broadleaved forest dominates, with such species as common China fir Cunninghamia lanceolata, Chinese cedar Cryptomeria fortunei, Masson pine Pinus massoniana, sweet gum Liquidambar sp., shining-leaf birch Betula luminifera, David maple Acer davidi, silverbell Halesia sp. and chinabells Alniphyllum sp. Between 1,700-1,900m coniferous forests of Taiwan pine, Chinese cedar Cryptomeria fortunei and Taiwan hemlock form the main vegetation; there are areas of brush and a thick layer of bryophytes on the forest floor. On the summit of Mount Huanggang, above 1,900m, sub-tropical mountain meadow flourishes: grasses, dominated by Chinese silver grass Miscanthus sinensis, common small reed Deyeuxia arundinacea and Arundinella spp., are accompanied by Japanese St. Johnswort Hypericum japonicum, sharp-leaf meadow rue Thalictrum acutifolium, climbing groundsel, David gentian Gentiana davidi, sassurea Sasurea spp., sedge Ixeris spp. and others. In addition to these climax vegetation types there are areas of Chinese hemlock forest Tsuga chinensis var. chekiangensis between 1,500-1,800m (Hanxi, 1983). These natural vegetation types are often interspersed with cultivated or quasicultivated forests of Chinese fir, Masson pine or bamboo; some of these are planted, others are secondary growth formed after clearing of the original broadleaf evergreen cover. In either case they form the region's main commercial forests (Wenhua and Xianying, 1989).

A total of 1,800 vascular plant species has been identified, from 798 genera and 191 families. The reserve contains some rare relict plants including the maidenhair tree Ginkgo biloba, Taiwan hemlock Tsuga formosana, Chinese yew Taxus chinensis, Chinese tulip tree Liriodendron chinense, Chinese bretschnidera Bretschneidera sinensis, Oyama magnolia Magnolia seiboldii, China cypress Glyptostrobus pensilis, Chinese torreyia Torreya grandis, Tsooniqidendron odorum, Emmonoptorys henryi and Tsuga chinensis (Anon., 1986).

161 species of fungi have been identified in the region (Hanxi, 1983). Some of these are favoured foods, such as Jew's ear Auricularia auricula; others have great medicinal value, such as glossy ganoderma Ganoderma lucidum and Chinese caterpillar fungus Cordyceps sinensis (Wenhua and Xianying, 1989).

**FAUNA** Species found in the area are representative of both central and southern China. The 100 mammal species identified (Hanxi, 1983) include stump-tailed macaque Macaca speciosa, rhesus macaque Macaca mulatta, small Indian civet Viverricula indica, large Indian civet Viverra zibetha, Asiatic golden cat Felis temmincki (I), clouded leopard Neofelis nebulosa (V), tufted deer Elaphodus cephalophus and mainland serow Capricornis sumatraensis. South China tiger Panthera tigris (E) may be present in the area (Wenhua and Xianying, 1989). Bangje (1987) reports that a tiger was injured and captured by hunters in the reserve in August 1986, but was later released back into the reserve. Tigers have also been reported from other areas within Fujian Province (Bangje, 1987). Of the 234 bird species present, the most notable are Cabot's tragopan Tragopan caboti (E), Elliot's pheasant Syrnaticus ellioti (E), silver pheasant Lophura nycthemera, spotted scops owl Otus spiculoccephalus, pale-headed woodpecker Gecinulus grantia, short-tailed parrotbill Paradoxornis davidianus, Rickett's hill partridge Arboriphila qingica (K), green shrike babbler Pteruthius xanthochlorus, white-backed woodpecker Dendrocopos leucotos, orange crowtit Paradoxornis nipalensis, red-tailed laughingthrush Garrulax milnei and mandarin Aix galericulata. The 72 reptile species include Aqkistrodon acutus, Naja hannah and Bungarus multicinctus. The 32 amphibian species include Rhacophorus chenfui and Straurois chunganensis. There are over 30 fish species recorded. There are between 5,000 (Anon., 1986) and 20,000 (Wenhua and Xianying, 1989) insect species, representing 31 of China's 32 orders (Wenhua and Xianying, 1989).

CULTURAL HERITAGE No information

LOCAL HUMAN POPULATION There are three villages with a total of 2,080 residents in the reserve. The nature reserve administration allows people to plant trees, collect bamboo, gather fungi, manage stock and practice agriculture within the experimental zone (Anon., 1986). There are areas of Chinese fir, Masson pine and bamboo forest, some of which have been planted. Others are of secondary origin formed after the clearing of broadleaf evergreen forests. All are important as they constitute the region's major commercial forests (Wenhua and Xianying, 1989).

VISITORS AND VISITOR FACILITIES There are more than 3,000 visitors annually (Anon., 1986).

SCIENTIFIC RESEARCH AND FACILITIES Extensive research has been conducted under the auspices of the Chinese Academy of Sciences and other educational and research establishments. Over the last 100 years 600 new species of plant and animal have been discovered in the mountains. Aspects of the site's geology, geomorphology, climatology, soil science, geobotany, zoology and microbiology have been investigated since 1979.

CONSERVATION VALUE The reserve has a very high diversity of plant and animal species, and contains many rare species. Over the last 100 years more than 600 new species of plants and animals have been discovered on the mountain and part of the area has been described as "one of the world's rare gene banks" (Wenhua and Xianying, 1989).

CONSERVATION MANAGEMENT The area is divided into two, a core area of 35,357ha and an experimental area of 21,180ha. No management plan appears to have been prepared. The local administration of the reserve gives talks to the local population and publishes the Wuyishan Newsletter for environmental education (Anon 1986).

MANAGEMENT CONSTRAINTS No information

STAFF Eighty-two

BUDGET No information

LOCAL ADDRESSES Management Division of Wuyishan Nature Reserve, Chongan County, Fujian Province

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## CHINA - Inner Mongolia

NAME Xilin Gol Natural Steppe Protected Area

IUCN MANAGEMENT CATEGORY IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 2.30.11 (Mongolian-Manchurian Steppe)

GEOGRAPHICAL LOCATION Situated on the Mongolian plateau in Xilin Gol District of the Inner Mongolian Autonomous Region. No information is available describing the boundary of the area. Abagnar Qi is the nearest town, situated just north of the reserve. 43°34'N, 116°22'E

DATE AND HISTORY OF ESTABLISHMENT The area was declared as a resource reserve and experimental/scientific reserve by Decrees of 19 May 1985. The decree takes the form of Document No. 89(85) and was issued by the General Office of the Inner Mongolian Autonomous Region Government. Accepted by Unesco as a biosphere reserve in March 1987.

AREA 1,078,600ha with a core zone of 1,471ha

LAND TENURE State

ALTITUDE 950-1,506m

PHYSICAL FEATURES The topography of the area consists of hills alternating with small basins in a region of extinct volcanoes. The semi-arid region is characterised by rivers that terminate in inland lakes without reaching any seas. Large lakes in the vicinity include Dalai Nur which is a perennial salt-lake and Qagan Nur which is a freshwater lake. Desert lies between Xilin River and Hulai Tu River, within the reserve. Xilin Gol River flows north through the area, leading to its end in a lake, 50 miles north of the town of Abagnar Qi, which itself is situated to the north of the reserve (Anon, 1986).

CLIMATE Mean annual temperature is 10.7°C and annual precipitation ranges from 326 to 448mm at 1,160m.

VEGETATION There are about 625 species of flowering plants, most of them xerophilous, including Mongolian elements. The dominant vegetation type is steppe and species include Aneurolepidium chinense, Stipa grandis, S. krylovii, Filifolium sibiricum and Cleistogenes squarrosa. Where the habitat is more sandy species include Picea meyeri, Populus davidiana and Ulmus pumila (Anon, 1986).

FAUNA Species include Mongolian gazelle Procapra picticaudata and rodents, such as daurian ground squirrel Citellus dauricus, daurian pika Ochtona daurica and Mongolian five-toed jerboa Allactaga sibirica. A number of raptor species have been recorded (Anon, 1986).

CULTURAL HERITAGE No information

LOCAL HUMAN POPULATION There are 1,200 families, with a population of 9,600 within the site (Anon, 1986).

VISITORS AND VISITOR FACILITIES No information

SCIENTIFIC RESEARCH AND FACILITIES Past surveys have included research on grassland vegetation and fauna. Current monitoring activities include monitoring the water quality of Xilin River. Accommodation is available for scientists and graduate students (Anon, 1986).

CONSERVATION VALUE It has been suggested that steppe ecosystems are poorly represented among China's protected areas (Wenhua and Xianying, 1985), giving this site a particularly high conservation value.

CONSERVATION MANAGEMENT There are five core areas, covering 1,471ha, which are closed to all activities. These are as follows: Chagan naubau meadow grassland (500ha), Hueiten Xile meadow grassland (311ha), Haliute plain steppe (500ha), residual Picea meyeri woodland (80ha), and residual poplar and birch woodland (80ha). Collaborative work has included an international symposium on grasslands in 1985 (Anon, 1986).

MANAGEMENT CONSTRAINTS No information

STAFF 122, including 20 administrative and 102 research and technical staff

BUDGET No information

LOCAL ADDRESSES The Management Office, Xilin Gol Natural Steppe Protected Area, Xilin Hot, Inner Mongolia

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## CHINA -Xinjiang Uygur

NAME Boghdad Mountain Biosphere Reserve

IUCN MANAGEMENT CATEGORY IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 2.36.12 (Pamir-Tian-Shan Highlands)/2.22.08 (Takla-Makan-Gobi Desert)

GEOGRAPHICAL LOCATION The reserve is situated in Fukang County, Changji Hui Autonomous Prefecture, in Xinjiang Uygur Autonomous Region, 50km north-east of the city of Urumqi. Boghdad Peak is the highest peak in the eastern part of the Tianshan Mountains and is on the edge of the Zhungeer Basin desert. 43°50'-44°30'N, 87°45'-88°05'E

DATE AND HISTORY OF ESTABLISHMENT Various parts of the reserve are protected by national or provincial legislation. The biosphere reserve contains several specific reserves: Tian Chi Nature Reserve, the Reaumuria Reserve and part of the Haloxylon ammodendron Reserve. The area was accepted as a biosphere reserve in 1990 (MAB China, 1990).

AREA 188,000ha, comprising a core area of 15,000ha and a buffer zone of 173,000ha. There is a transition area of 29,000ha (MAB China, 1990).

LAND TENURE Tian Chi Natural Reserve is state owned and an area is also owned by the Academia Sinica (MAB China, 1990).

ALTITUDE 450-5,445m

PHYSICAL FEATURES Altitude decreases fairly uniformly from south to north, with the snow- and ice-covered Boghdad Mountain at one extreme and the Kurbantonket and Sacsaul deserts on the lower, northern edge. Three main rivers drain the area, including the Sangonghe River which flows from Tian Chi (heavenly) Lake. These rivers peter out in a number of distributaries at the edge of the desert area. The region was glaciated four times during the Quaternary. The rocks have also been subjected to strong upwarping in the Permian, Jurassic, Cretaceous and Quaternary. Deep Quaternary deposits, at least 300m thick, have accumulated on the plains and there are also deposits of loess. The plains have mainly saline and desert soils (MAB China, 1990).

CLIMATE Continental desert type climate of the temperate zone. In the mountain area the annual precipitation is over 700mm but only 150mm in the plain. At 1,911m mean annual precipitation of 530mm has been recorded. Evaporation can be as high as 1960mm per annum. The maximum average temperature of the warmest month is 25.8°C and the minimum average temperature of the coldest month is -19°C (MAB China, 1990).

VEGETATION Several zones exist due to the great altitudinal range included. Below the snow and ice region of the peak there are alpine meadows with Festuca, Stipa, Rosa alberti and Artemisia. The forests below this are dominated by Picea schrenkiana. The main species planted or managed for forestry are poplar Populus diversifolia, elm Ulmus pumila and Elaeagnus angustifolia. In the desert area vegetation is sparser but includes Reaumuria, and Haloxylon ammodendron in areas of dunes. Endangered species which have been identified include Saussurea involucreata, Fritillaria walujewii, Haloxylon ammodendron and H. persicum (MAB

China, 1990).

**FAUNA** An estimated 21 species of wildlife live in the reserve. Internationally or national threatened species within the biosphere reserve include the mammals: brown bear Ursos arctos, marten Martes foina, otter Lutra lutra, lynx Felis lynx, Pallas' cat F. manul, snow leopard Panthera unica (E), Sikkim stag Cervus elaphus, Equus hemiquus, E. przewalskii (E), Gazella subgutturosa, Capra sibirica, argali Ovis ammon (I) and saiga antelope Saiga tatarica, and birds: black stork Ciconia nigra, black kite Milvus migrans, long-legged buzzard Buteo rufinus, european sparrowhawk Accipiter nisus, booted eagle Hieraetus pennatus, griffon vulture Gyps fulvus, European hobby Falco subbuteo, common kestrel F. tinnunculus and Himalayan snowcock Tetraogallus himalayensis (MAB China, 1990).

**CULTURAL HERITAGE** No information

**LOCAL HUMAN POPULATION** Very few people live in the core area but there are several hundred in the buffer zone, some of whom are nomadic. About 120,000 live in the transition areas (MAB China, 1990).

**VISITORS AND VISITOR FACILITIES** There are about 500,000 visitors per year (MAB China, 1990).

**SCIENTIFIC RESEARCH AND FACILITIES** There are 30 research staff of which 10 hold doctorates and 12 another university degree, with a technical support staff of eight. Academia Sinica has the Fukang Desert Ecosystem Research Station which is managed by Xinjiang Institute of Biology, Pedology and Desert. It is estimated that about ten foreign scientists are also participating in research at this site. An integrated study involving the effects of population and resource use on the environment in the Sangonghe river valley is planned. Sustainable grazing and artificial improvement of grassland is being studied in the buffer zone. It is hoped that a botanic garden of economically useful desert plants can be set up, as well as a facility for breeding wild animal species, particularly Saiga tatarica and Equus przewalskii, for return to the wild (MAB China, 1990).

**CONSERVATION VALUE** The reserve is typical of the eastern part of the Tian Shan Mountains and includes an altitude range of 5,000m. This results in a number of habitat zones, from snow and ice, alpine meadows, through various forest communities and including areas of desert at the foot of the mountains. The fauna is varied and includes threatened species such as snow leopard Panthera unica (E), E. przewalskii (E) and argali Ovis ammon (I)

**CONSERVATION MANAGEMENT** There are several different reserves which comprise the biosphere reserve: Tian Chi Reserve, the Reaumuria Reserve and part of the Haloxylon ammodendron Reserve (over 700,000km<sup>2</sup> in total) (MAB China, 1990).

**MANAGEMENT CONSTRAINTS** Wood-cutting and animal husbandry, particularly grazing of the alpine meadows, are the only major disturbances in the core area. Grazing also occurs in the desert areas, including that by domesticated sheep, cattle, goats, pigs and camels. A variety of crops including cereals, melons, alfalfa and hops, are also cultivated here. Part of the area of desert with Haloxylon ammodendron and Reaumuria has been destroyed, the former being scarce in Xinjiang. There is tourist activity in the forested parts. Oil and gas development are occurring in the buffer zone (MAB China, 1990).

STAFF Total of 60, including 30 for administration, control and resource management of which six are university trained; six for education and training and 30 who are involved in research (MAB China, 1990).

BUDGET 6 million RMB

LOCAL ADMINISTRATION Xinjiang Institute of Biology, Pedology and Psammology, Chinese Academy of Sciences, Beijing Road, Urumqui

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## CONGO

NAME Réserve de la biosphère de Dimonika

IUCN MANAGEMENT CATEGORY VIII (Multiple Use Management Area)  
IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 3.02.01 (Congo Rain Forest)

GEOGRAPHICAL LOCATION In the Kouilou region, 130km north-west of Pointe-Noire and 50km from Loubomo. Bounded to the north by the River Loubomo, and for a short distance by the River Louilou, and to the south by the Route Nationale 1. The east and west boundaries are 12°32'E and 12°12'W, respectively. 3°57'-4°29'S, 12°10'-12°32'E

DATE AND HISTORY OF ESTABLISHMENT Declared a biosphere reserve on 1 March 1988 by Decree 181/88 and accepted by the Unesco-MAB Bureau shortly afterwards. The area of the reserve when it was first nominated was 62,500ha, but it has since been increased by moving the western boundary some 15km west.

AREA 136,000ha. Central zone of 91,000ha, buffer zones of 20,000ha and 7,000ha, and a zone of influence of 18,000ha

LAND TENURE State

ALTITUDE 85m-810m (Mount Bamba)

PHYSICAL FEATURES The reserve is situated in the central Mayombe which are mountain chains of Appalachian type, oriented north-west/south-east, parallel to the coast. Rocks are mainly pre-Cambrian in origin and have been subjected to movement and tilting during the Cretaceous period. The mixture of hard bands of quartzite with schists and other softer rocks has led to a fairly rugged relief. The highest peaks within the reserve are to be found in the north-east separated by deep, enclosed valleys and ravines, with narrow crests dominating wider valleys towards the south-west. To the west, these pre-Cambrian deposits are bordered by cretaceous formations overlain with tertiary sands, while to the east there are calcareous deposits. The hydrographic network is fairly dense; the principal rivers are the Loubomo and Ngoma na Ngoma, both of which join the Kouilou, and the Loukéné which flows south towards the Loémé.

CLIMATE Conditions are sub-equatorial lower-Congo, with average precipitation varying from 1300mm in the north-east to 1700mm in the south-west. From 1979 to 1983 in Dimonika (at 500m altitude) average annual precipitation was 1350mm, average annual temperature 23.3°C. During the dry season, May to September, precipitation is less than 50mm per month and temperatures average 22°C, although relative humidity is always high and there are fogs most mornings. The wet season lasts from October to April, with February the wettest month at 250mm.

VEGETATION The reserve is mostly forested, with some savanna vegetation. Kiyome Forest, which covers most of the reserve, is sub-equatorial, with semi-deciduous forest verging on dense evergreen cloud forest. The forest comprises four types: one dominated by Olacaceae, Burseraceae and Guttiferaceae; Gilbertiodendron dewevrei in ravine bottoms; Aucoumea klaineana savanna and semi-anthropic Terminalia superba around Dimonika. The central zone of the reserve is essentially covered by the first of these types which characterises Kiyombe

Forest. The forest cover in the north and east is broken by savannas of Hyparrhenia and marked bush layer of Annona arenaria, Nauclea latifolia and Hymenocardia acida. Some of the savanna is thought to have a climatic origin, but is maintained by fire.

**FAUNA** There is a rich and varied fauna which includes gorilla Gorilla gorilla, chimpanzee Pan troglodytes, Cercopithecidae, mangabeys, lemurs, duikers, sitatunga, water chevrotain, bush pigs, brush-tailed porcupines, Viverrids such as civets, genets, mongooses, tree hyrax Dendrohyrax arboreus, elephant Loxodonta africana cyclotis, buffalo, bushbuck Tetracerus scriptus, pangolin Manis spp., golden cat Felis aurata. Some 100 species of bird have been identified. Reptiles include two species of tortoise, monitor Varanus niloticus, Crocodylus cataphractus and Osteolaemus tetraspis (both threatened) and 45 species of snake. Twenty-three species of scarab beetle have been identified to date, and 106 longicornes, 65 sphingid moths, 28 species of sand fly and 71 of fruit fly.

**CULTURAL HERITAGE** No information

**LOCAL HUMAN POPULATION** There are some 8,600 inhabitants in and around the reserve: 664 in buffer zone No. 2 and 7,900 along RN 1. About half of this number live directly off reserve lands. The nearest towns are Pointe-Noire (335,000 inhabitants) 130km distant and Loubomo (60,000 inhabitants) 50km away. Principal activities are subsistence agriculture such as collecting forest products, hunting, fishing and pasturing.

**VISITORS AND VISITOR FACILITIES** No information on current activity, although IUCN (1988) suggests that high rainfall within the reserve may restrict the development of tourism.

**SCIENTIFIC RESEARCH AND FACILITIES** Floral and faunal surveys have been and are being undertaken under the Mayombe Project (UNEP/Unesco-ORSTOM/Marien N'gouabi University, Brazzaville), along with ongoing and planned studies by social scientists and medics, research on agricultural systems, and studies of ecosystems, hydrology, geology, soils and atmosphere. All these studies are part of a larger project to establish a sound basis for the protection of biodiversity, and the rational management of natural resources within the region.

**CONSERVATION VALUE** The area is an important watershed for the sublittoral forests and savannas extending towards the Atlantic Ocean, and is crucial to the maintenance of the region's food production. According to IUCN (1988), destruction of the rain forest would have disastrous consequences for an area stretching right to the coast. The reserve's physiographical, biological and ecological characteristics are of scientific interest. For example, Kiyombe Forest is particularly interesting, first because it is really on the limit between semi-deciduous and evergreen forest, and secondly because it contains various different types of forest community recolonising old areas of forest exploitation.

**CONSERVATION MANAGEMENT** An initial management plan was proposed in 1988 in order to put in place the structures and logistical means necessary for surveillance activities and to counter poaching. The aims of the reserve, identified in an annex to the nomination, closely follow the major headings in the Action Plan for Biosphere Reserves. The reserve comprises four zones. The central (core) zone occupies the northern two-thirds of the reserve, and is an area where all human activity is prohibited, and where entry and movement is regulated by ministerial decree. There is a transition zone along the road, and buffer zones south of

4°16'S and around the settlements within the reserve. Agriculture and collection of forest products are permitted within these zones, and traditional forms of hunting are also allowed (firearms are prohibited throughout the reserve). The reserve is administered by the Ministère de la Recherche scientifique des Eaux et Forêts based at Pointe Noire. Staff of the research station at Dimonika undertake local surveillance and control activities. A development committee for the Mayombe encourages participation by local populations in management of the reserve.

MANAGEMENT CONSTRAINTS There are some problems associated with human pressure in the buffer zones, a lack of control over forest cultivation, logging activities and gold diggers who undertake traditional and commercial hunting in the reserve. Exploitation of commercial forest species will continue within two blocks until 1992 when all rights of exploitation within the reserve expire. The larger of the two blocks (23,500ha) is within the central zone.

STAFF A conservator and a number of guards were proposed in 1988.

BUDGET No information

LOCAL ADDRESSES Ministère de la Recherche scientifique des Eaux et Forêts, Pointe-Noire

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## COSTA RICA

NAME Reserva de la Biosfera de la Amistad

IUCN MANAGEMENT CATEGORY IX (Biosphere Reserve)  
X (World Heritage site - Criteria: i, ii, iii)

Composed of a range of protected areas of various categories, including two national parks (II), two biological reserves (I), seven anthropological reserves (VII), one protection forest (VIII) and one forest reserve (VIII).

BIOGEOGRAPHICAL PROVINCE 8.16.04 (Central American)

GEOGRAPHICAL LOCATION The park lies in the foothills and mountains of the Cordillera de Talamanca, between the mountain ranges of Las Vueltas, Cartago and Echandi on the Panamanian/Costa Rican border, and falls within Limon, Puntarenas, San José and Cartago provinces in Costa Rica, adjacent to the proposed park in Boscas de Toro and Chiriqui provinces in Panama. The Panamanian park is planned to adopt the 1,800m contour as its park boundary. 8°44'-10°02'N, 82°43'-83°44'W

DATE AND HISTORY OF ESTABLISHMENT The Presidents of Costa Rica and Panama jointly declared intent to establish an international park on 3 March 1979, and this was reconfirmed in Costa Rica by Presidential Decree of 4 February 1982. The Costa Rican portion was accepted as a biosphere reserve in 1982. Declared a World Heritage site in 1983. The Reserva Forestal de Rio Macho extension to the reserve was approved by the MAB Bureau on 27 January 1988. La Amistad International Park is still at a proposal stage.

AREA 584,592ha, including 51,150ha in Chirripo National Park, 190,000ha in Cordillera de Talamanca National Park, 9,000ha in Hitoy-Cerere Biological Reserve, 10,000ha in Barbilla Biological Reserve, 19,000ha in Las Tablas Forest Protection Zone and 84,592ha in Rio Macho Forest Reserve. There are also Las Tablas (19,602ha), and Telire (9,187ha), Tayni-Estrella (12,477ha), Talamanca (56,830ha), and Ujarras-Salitre-Cabagra (57,452ha) Indian reserves. The Panamanian park is planned to cover 120,000ha.

LAND TENURE 95% of the land within the core areas is government property, but there are small scattered agricultural developments along the borders. The remaining 5% is being surveyed and will be purchased or expropriated in the near future. There are sizeable holdings of private land within Las Tablas Protection Forest although the remainder is state-owned. Expropriation of this land is not foreseen, but legislation prohibits changes in existing land use and 90% consists of undisturbed forest. Within the Indian reserves, the Indian population has exclusive rights to the land in perpetuity, but non-Indian settlers are gradually being relocated. The botanical garden is owned by the Universidad Estatal a Distancia.

ALTITUDE 50m-3,820m (Cerro Chirripo, the highest point in southern Central America)

PHYSICAL FEATURES The Cordillera de Talamanca is the highest and wildest non-volcanic mountain range in Central America. It was formed by the orogenic activity which created the land dividing the Pacific Ocean from the Caribbean. After a long period of marine deposition in the shallow surrounding seas up to the Middle Miocene, a period of marine volcanism began which included the intrusion

of a huge granitic batholith, and the uplifting of the whole area to some 4,000m above sea level in the Plio-Quaternary orogenesis. The peneplain thus formed has been gradually eroded due to heavy rainfall, creating a rugged topography with many slopes inclined at over 60°. During the Quaternary, glaciers carved cirque lakes and steep valleys on the slopes of Chirripo National Park, the only area in Central America to show signs of glaciation. Most soils are poorly evolved inceptisols (leached soils).

**CLIMATE** Average temperatures range from above 25°C near sea level to -8°C on the highest peaks. Mean annual precipitation varies from around 2000mm near the Caribbean coast to more than 6000mm on some high montane areas.

**VEGETATION** Tropical rain forests have covered most of the area at least since the last glaciations about 25,000 years ago. Of the twelve life zones of Costa Rica, at least eight occur in the park, including lowland tropical wet rain forest to cloud and sub-alpine paramo forests, pure oak stands, lakes of glacial origin and high altitude bogs. The latter four communities are not found elsewhere in Central America. The area also contains all five altitudinal zones found in the tropics. Most of the main crest lies within the montane rain forest life zone, characterised by mixed oak forest; a dense, low and heavily covered forest with bryophytes, ferns, bromeliads, orchids and other epiphytes. Below 2,500m the lower montane rain forest life zone occurs and the forest is generally more mixed. The Talamanca Mountains contain the largest tracts of virgin forest in Costa Rica. On high points along the ridge, at elevations above 2,900-3,100m, frequent stands of paramo, swamps, cold marshes and Aretostaphylos arbustoides occur. The paramo located on Mt Kamuk contains the richest and most varied vegetation (after Chirripo) in the entire Talamanca Range and is the only one in Costa Rica that shows no signs of human intervention. The whole area contains a diversity of plant genera, families or species perhaps unequalled in any other reserve of equivalent size in the world, due to the convergence of the floras of North and South America and varied climatic and edaphic factors.

**FAUNA** The fauna is extremely diverse, with intermigrations from both North and South America. Studies indicate that one out of the 115 species of fish, 20 out of the 250 species of reptile and amphibian, 13 out of the 215 species of mammal and 15 of the 560 species of birds are endemic to the reserve. Signs of tapir Tapirus terrestris, possibly of a species as yet unrecorded in Costa Rica, are abundant at Cerros Utyum, Kamurk and Fabrega near the Panamanian border. All the Central American felines are found including puma Felis concolor, ocelot F. pardalis (V), jaguarundi F. yagouaroundi (I), tiger cat F. tigrina (V), and the jaguar Panthera onca (V) and also Central American tapir Tapirus bairdii (V), Central American squirrel monkey Saimiri oerstedii (E) and Geoffroy's spider monkey Ateles geoffroyi (V). Bothrops negrvisidis, a green and black high-altitude viper that has been rarely seen or collected, is present. Resplendent quetzal Pharomacrus mocinno (V) is present in the park as are many other bird species, such as bare-necked umbrella bird Cephalopterus glabricollis, three-wattled bellbird Procnias tricarunculata, harpy eagle Harpia harpyia (R), crested eagle Morphnus guianensis (R), solitary eagle Harpyhaliaetus solitarius and orange-breasted falcon Falco deiroleucus. It has been suggested that no other park is the world possesses as many species and such a wealth of fauna. La Amistad includes 9 of the 11 birds listed as 'endangered' by Costa Rica, 13 of their 16 'endangered' mammals, and all their reptiles and amphibians.

**CULTURAL HERITAGE** Archaeological sites are reported along all major water courses, yet an almost total lack of archaeological investigation within the area makes objective analysis of the human history difficult. However, less than 50km

away, near Baru Volcano in Chiriquo Panama, pre-ceramic sites have recently been discovered dating back more than 12,000 years. Such sites are extremely rare in Central America, but this discovery just a short distance away indicates the possibility of more finds of Central America's earliest human inhabitants in the area. Studies on the Pacific Slope of Costa Rica just a few kilometres from the proposed Talamanca-La Amistad World Heritage Site have revealed much about the area's pre-Colombian inhabitants. Skilfully-created elaborate zoomorphic and anthropomorphic gold ornaments and jewellery and huge symmetrical stone spheres up to 2m in diameter are among the most outstanding evidences of the cultural development of pre-Colombian man in the area over the last 3,000 years. Analysis of polychrome pottery found in digs has led to definition of two major cultural phases for the area: the Agua Buena phase lasted from 300 BC to 500 AD and the Chiriqui phase from 500 AD until the Spanish Conquest. The recent discovery of pre-ceramic sites in the region surrounding the site presents a 10,000-year gap in the archaeological record of the area of great interest to scientists. Further details are given in Torres et al. (1987).

LOCAL HUMAN POPULATION At the time of the Spanish conquest, a number of Indian tribes inhabited the Talamanca Range. Their numbers were decimated by conflict with Spanish settlers and imported diseases over the following centuries, and by 1940 only 6,000 Indians were left in Costa Rica along isolated river valleys in still unsettled terrain. Since then, increased public and governmental interest in their plight has led to a gradual increase in their numbers and legal recognition of their land rights. Approximately 10,000 Indians of the Bribri, Cabecar, Brunca and Guaymi tribes live within the area's boundaries. These populations represent nearly 100% of the total population of Bribris and Cabecars, and an important percentage of the remaining population of Guaymis and Bruncas left in the world. These groups have experienced varying degrees of cultural contact for over 400 years, yet have retained much of their folklore, language, customs, and subsistence agricultural, hunting and gathering lifestyle.

VISITORS AND VISITOR FACILITIES No information

SCIENTIFIC RESEARCH AND FACILITIES Apart from a number of anthropological surveys, no comprehensive scientific studies have been conducted within the area. There are some research facilities, in particular at Las Cruces Botanical Garden. Chirripo National Park, Cordillera de Talamanca National Park, and Las Tablas Forest Protection Zone are used for field training activities for university students.

CONSERVATION MANAGEMENT The core area is made up of Chirripo National Park, Cordillera de Talamanca National Park, Hitoy Cerere Biological Reserve and Barbilla Biological Reserve, all managed by the Costa Rican National Park Service. The buffer area consists of the Indian reserves of Talamanca, Tayni-Estrella, Telire, Chirripo, Cabagra, Salitre and Ujarras (together covering 217,441ha) as well as Las Tablas Forest Protection Zone (managed by the Costa Rican Forest Protection and Las Cruces Botanical Garden (115ha). The area is made up of a complex of reserves with various types of legal protection, and has only recently been legally protected as a whole, by means of executive laws passed by the legislative assembly. Changes of land use are prohibited within the privately owned areas of the Las Tablas area but within the Indian reserves the Indian populations have exclusive rights to the land. Barbilla Biological Reserve has yet to be legally established. More recently, Reserva Forestal de Rio Macho was officially incorporated into the reserve. A management plan for the major part of the site is being prepared. The plan will include very detailed recommendations for the management and development of Cordillera de Talamanca

National Park and Las Tablas Forest Protection Zone. For the other reserves, more conceptual recommendations on land use and resource protection will be outlined. The preparation of this plan is being coordinated by specialists from the Wildlands and Watershed Programme of CATIE. The first stages of the planning process, resource inventories and basic information collection, were completed in 1982. Simultaneously, a planning team from Costa Rica's National Autonomous University is preparing a detailed management and development plan for Chirripo National Park. Short-term management of protected wildlands within the proposed World Heritage site is undertaken based on objectives, priorities and activities outlined in annual operational plans for these management units. Guard patrols and overflights assure the integrity of resources within the natural reserves included in the site's proposed boundary. From 1985 to 1987 an interdisciplinary team (Torres *et al.*, 1987) from CATIE and the National Park Service implemented a planning project in order to produce a regional conservation and development strategy.

There are two levels of zoning: one at the general level of the biosphere reserve as a whole which is managed as one unit, and another within each specific reserve according to their different statutes. The other reserves of the overall biosphere reserve will be generally managed with natural zones, cultural zones, recovering zones and forest management zones. Funds were being raised during 1985 and 1986 in order to purchase privately held land, although this did not proceed as planned. An environmental education programme has been underway since September 1984 in the indigenous reserve and colonist communities adjoining the Atlantic slope.

**MANAGEMENT CONSTRAINTS** There are several Indian reservations near or contiguous to the area and man's impact in them is considerable, with about 10,000 people maintaining their traditional lifestyles of free-range grazing, hunting, fishing and use of medicinal plants. Oil exploration in Talamanca Reserve is a problem, as is forest loss and soil degradation in the Ujarras, Salitre and Cabagra area. Land squatters on the Pacific side of Costa Rica are known to exist. If settlers can provide documentary evidence of more than 10 years occupancy, their removal requires compensation under agrarian law. Parts of the buffer zone have been affected by shifting cultivation and forest use, resulting in forest destruction, habitat elimination and watershed degradation. Without outside help it will not be possible for the rangers to control poaching, archaeological site looters and squatters. Additional threats are posed by development projects proposed for areas in or near the reserve. These include construction of a cross-Talamanca highway and copper mining. During 1983/84 it was reported that poaching, looting of archaeological sites and encroachment by colonists, particularly along the Pacific slopes of Chirripo, the Cordillera de Talamanca and Las Tablas Forest Protection Zone were posing a threat to the site. Insufficient funding had led to inadequate staff training, equipment, infrastructure, border delineation and baseline surveys.

**STAFF** For the various reserves, national parks etc. that make up the biosphere reserve, there are 45 full-time employees and 20-30 part-time, mostly engaged in protection and surveillance. There are also research workers at various times undertaking specific studies.

**BUDGET** The governments of Costa Rica and Panama have assigned US\$ 600,000 for resource inventory and management planning for 1981-83.

1983 - UNESCO assigned US\$11,800 towards a comprehensive course for all park personnel. 1983/84 - WWF Tropical Forest Campaign assigned US\$40,000 for essential equipment and construction work.

LOCAL ADDRESSES Servicio de Parques Nacionales de Costa Rica, Barrio Aranjuez, Costado Norte Hospital Calderon Guardia, Apartado 10094, SAN JOSE

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## COSTA RICA

NAME Cordillera Volcanica Central

IUCN MANAGEMENT CATEGORY IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 8.16.04 (Central American)

GEOGRAPHICAL LOCATION Situated 15km north of the capital San José. The southern limit runs along the Cordillera Volcanica Central and includes the Barva, Cacho Negro, Irazu and Turrialba volcanoes; Rio Puerto Viejo is the eastern limit and the Sarapiquí road is the western limit. The basins of the rivers Sarapiquí, Sucio and Chirripo are included in the biosphere reserve (Anon., n.d.). 10°03'N, 84°00'W

DATE AND HISTORY OF ESTABLISHMENT Established as a forestry reserve under Forestry Law No. 4465-A of 25 November 1969 and Decrees No. 4961-A of 26 June 1975 and No. 5386-A of 28 October 1975. Irazu National Park was established under Decree No. 1917 of 30 July 1955 and La Selva Protected Zone under Decree No. 13495-A of 31 March 1982. Braulio Carrillo National Park was established under Decree No. 8357-A of 15 April 1978 and Law No. 6280 of 25 October 1978. The extension of the park was authorised by the Decree No. 17003-MAG of 13 April 1986 (Anon., n.d.).

AREA Total area 144,363ha, core area 44,901ha. Protected areas within the reserve include Braulio Carrillo National Park (the core area), Irazu National Park (2,308ha), Reserva Forestal Cordillera Volcanica Central (61,541ha) and La Selva Biological Station (1,333ha) (Anon., n.d.).

LAND TENURE A mixture of government and private ownership: national parks are government owned (47,209ha); the forestry reserve is state and privately owned (61,541ha); La Selva Biological Station (1,333ha) is private and so are the remaining 34,280ha (Anon., n.d.).

ALTITUDE 37m-3,432m

PHYSICAL FEATURES The reserve has a large number of craters with both extinct and active volcanoes. In the Cordillera there are canyons and gorges where slopes are very abrupt with inclinations of over 60%. The large rivers in the area contribute to the formation of extensive alluvial fans in the north where the land is flatter and undulating. Some soils are of volcanic origin and some alluvial (Anon., n.d.)

CLIMATE Mean annual temperatures are 26°C at an altitude of 80m and 14°C at 3,432m. Mean annual rainfall figures are available for different altitudes: 4374mm at 80m, 4986mm at 250, 5449mm at 500m, 3315mm at 1,800m and 2530mm at 3,432m (Anon., n.d.).

VEGETATION The flora is rich as a result of the nearly continuous primary forest, which extends from the top of Barva Volcano to the Atlantic plains (covering seven life zones). This primary forest area ranges from 37m to 2,835m in altitude and is the only forest of this type in Central America. There are over 4,000 species of higher plants with some undescribed species. In 1983, a two-week expedition in the area discovered 28 new species and 12 species previously unknown in Costa Rica (Anon., n.d.). There are over 450 tree species at La Selva alone (Clark, in

press), and in the whole of the biosphere reserve there are at least 75 tree species which are unprotected elsewhere in the country (Anon., n.d.). Uncommon tree species include Metaxya rostrata, Tectaria brauniana, Justica sarapiquensis, Sphaeradenia carrilloana and Asplundia ferruginea (Anon., n.d.).

**FAUNA** As many as 500 species of birds, 135 mammals and 125 reptile and amphibian species (the richest in the tropics) are found in the reserve. These species numbers represent 70%, 75% and 65% of the total number of species found in the country, respectively. Some threatened species such as jaguar Panthera onca (V), puma Felis concolor and Central American tapir Tapirus bairdii (V) are present, with another 24 species potentially at risk. Species like Popelaria canversii, Microclera albocoronata, Notharchus tectus, Piprites griseiceps, Pharomachrus mocinno and Chamaepetes unicolor are unprotected elsewhere in the country (Anon., n.d.). Additionally, within La Selva Biological Reserve alone, 389 bird species have been recorded (Styles, 1977) and 104 mammals (Wilson, in Anon., 1984).

**CULTURAL HERITAGE** No information

**LOCAL HUMAN POPULATION** There are some private properties in the low and humid lands of the western region of the forest reserve, in which cattle ranching is the main activity. A large number of well administered dairies also exist, as well as citrus orchards and some agroforestry developments (35,990ha). To the west, on the highlands, there are non-traditional crops and a sustainable land use has been achieved. In the east of the park (Braulio Carrillo) there is a 14,490ha primary forest in private ownership with proposals for its sustainable use along with timber export plans endorsed by the Direccion General Forestal (Forestry General Direction) (Anon., n.d.).

**VISITORS AND VISITOR FACILITIES** Access is by road to Barva and Irazu volcanoes. The biosphere reserve includes two of the three most visited parks in the country with over 23,487 visitors per year. A road connecting the Atlantic part of the country with the capital was planned for 1987 (Anon., n.d.). La Selva is visited by large numbers of students throughout the year and, more recently, non-scientific visitors interested in natural history have been allowed into the area subject to availability of space (Clark, in press). In 1985, the station's use averaged 22 persons per day; 70% were researchers, 20% natural history groups and 10% staff from the Organization for Tropical Studies (OTS) and visitors (Clark, in press).

**SCIENTIFIC RESEARCH AND FACILITIES** Research is permitted in the core area (Braulio Carrillo NP) provided that appropriate licences are obtained. La Selva Biological Station is one of the most active sites for biological research in the Neotropical world and is administered by the OTS. It is adjacent to the northern section of the park (Anon., n.d.) and during 1985 more than 100 separate research projects were carried out; facilities at the station were improved in 1986 and it is expected that the rate of use has increased (Clark, in press). More than 1,500 graduate students from various countries have been trained there (Anon., n.d.; Clark, in press). The OTS has an environmental education programme for local people, produces teaching material for schools and organises special workshops. Research includes studies on wildlife biology, reforestation, long-term ecology and climatology. Rainfall records are available for the area since 1957; temperature records were started in 1981; investigations into the growth, mortality and regeneration of plants higher than 10cm started in 1970 within a 12.4ha area of primary forest. Other projects carried out during the last few years include one on the growth and mortality of 1,500 trees in six different species. There is scientific cooperation with the Smithsonian Tropical Research

Institute in Panama (Anon., n.d.). Research and field stations, experimental plots and accommodation for 65 scientists exist. There is adequate access to the biosphere reserve from existing roads (Anon., n.d.).

**CONSERVATION VALUE** The site was established due to the number of interesting features such as the large number of craters, rich flora and fauna and its importance as a centre of great biological diversity. The importance of Braulio Carrillo lies in the protection of resident migratory species which include mammals and hundreds of birds that benefit from the wide range of habitats in the park (Anon., n.d.).

**CONSERVATION MANAGEMENT** There is a management plan for the biosphere reserve. Management plans for Braulio Carrillo and Irazu national parks and La Selva Biological Station also exist. The management plan for Braulio Carrillo, includes detailed studies on biological, physical and cultural resources. A plan for environmental education also exists as a supplement to the management plan. It includes details of the programmes and activities to be carried out in the area of influence of the park and neighbouring communities. Some of the proposals include the creation of a national environmental education centre which will train students, professionals and park personnel. Park rangers currently carry out environmental education around the park (Anon., n.d.). La Selva's management plan for the field station proposes to promote and facilitate scientific research on tropical lowland rain forest by studying the rational use of disturbed habitats, preserving representative samples of primary rain forest and by maintaining communities for research and education. It also aims to serve as a facility for university-level education in tropical life sciences and as a general facility for biological and conservation education of the public (Anon., 1984). In La Selva, areas of strict protection, areas with little management and experimental areas have been designated. A management plan for the forestry reserve is in progress (Anon., n.d.).

Hunting and tree felling are prohibited in the core area. Within the forest reserve there are a large number of dairies and land suitable for forest management. The dairies are well managed and use a rotation system for pastures. Private plots to the north, which are situated within the new extension of Braulio Carrillo NP, are being bought to allow the land to return to its natural state. Properties dedicated to cattle ranching surround the park (Anon., n.d.).

OTS frequently discusses projects of common interest with the Municipality of Sarapiquí, such as a new aqueduct for Puerto Viejo and a project for the exchange of scientific information. An inter-institutional advisory committee discusses the management and protection of the biosphere reserve and includes representatives of the National Park Service, the General Forestry Directorate, Parks Foundation, OTS, Institute of Agricultural Development, CATIE and members of the National MAB Committee (Anon., n.d.).

**MANAGEMENT CONSTRAINTS** Soil degradation is caused by cattle ranching and grazing in the western area of the forest reserve. Agriculture (citrus fruit) and agroforestry systems exist. Human settlements are located within the biosphere reserve. A national road passing through the park, which would link the Atlantic zone of the country with the capital city, was expected to be completed in 1987. At present, there is access by road to two volcanoes, Barva and Irazu, which together attract a large number of visitors each year (over 23,487) (Anon., n.d.). Their impact on the biosphere reserve and the parks may go beyond the limits established by reserve regulations. In La Selva, deforestation has occurred mainly because of agricultural use, predominantly for low-quality cattle pasture,



even on the steep foothills. On these slopes, unproductive pastures which are highly susceptible to erosion are quickly invaded by woody scrub, and the farmers either eventually sell or abandon the pastures (Clark, in press).

STAFF Total staff of 85, with six people working on administration, control and resource management.

BUDGET No information

LOCAL ADDRESSES Ministerio de Agricultura y Ganaderia, Servicio de Parques Nacionales, Apartado 10094, SAN JOSE

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## CUBA

NAME Baconao Biosphere Reserve

IUCN MANAGEMENT CATEGORY V (Protected Landscape)  
IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 8.39.13 (Cuban)

GEOGRAPHICAL LOCATION Situated 150km from the eastern end of Cuba, the area borders the south coast and includes parts of Santiago Province and Guantánamo Province. The administrative town of Santiago de Cuba is situated 2km west of the biosphere reserve and the coastal towns of Siboney and Daiquiri are situated within the area. 19°52'-20°08'N, 75°16'-75°46'W

DATE AND HISTORY OF ESTABLISHMENT The area forms part of the Gran Parque Nacional Sierra Maestra which was created in 1979 by Law No. 27. It was accepted by Unesco as a biosphere reserve in October 1986.

AREA 84,600ha, extending up to 22km inland and following 65km of coastline. This is contained within the Gran Parque Nacional Sierra Maestra which covers an approximate area up to 25km wide along about 250km of coastline.

LAND TENURE State

ALTITUDE The topography rises from the Santiago basin to the west to the Gran Piedra Sierra in the centre of the reserve and slopes down into Guantánamo province to the east (0-1,123m).

PHYSICAL FEATURES Although part of the Gran Parque Nacional Sierra Maestra, the area is separated from the Sierra Maestra mountain range by the Santiago basin. Three topographical zones have been identified within the area: low altitude plateau which runs along the coast from the Santiago basin eastwards into Guantánamo province; Gran Piedra Sierra where the highest land is found; and the Santa Maria de Loreto table, 600m above sea level. The physiography of the area consists of sandstone and agglomerate underlying alluvial valleys, coastal tablelands and foothills (up to 400m) while granitic rocks underlie low mountains (400-1200m). The central area is composed of Paleocene-Eocene volcanoclastic rocks of the Cobre Formation, comprising fragments of travertine and agglomerate, with intercalations of sandstone, travertine and tuff. The complex is cross-cut by large batholithic intrusions, intermediate in composition and consisting of granodiorite and diorite.

CLIMATE Mean annual temperature is 24.7°C and mean annual rainfall is 700mm at sea level. The northern slope is more humid with annual precipitation of 1,500mm at the highest level. Winds are predominantly from the north-north-east, north-east and south.

VEGETATION The most important formations are coastal and sub-coastal xeromorphic bush forest with an abundance of tree and column cactii; coastal rocky and sandy vegetation; mangroves; rain forest; cloud forest; mesophilic evergreen forest; gallery and pine forest. Oriental, Sierra Maestra and Pancubano species, with phyto-geographic affinity with the Caribbean, Neotropical and Antillean regions, are found here. One hundred and thirty eight endemic species have been recorded, including 12 hepatics and three rare and endangered species: Melocactus acunai,

M. harlowii, Trichipteris striquillosa.

**FAUNA** Some 919 species of fauna, comprising 19 mammals, 60 birds, 29 reptiles, 24 spiders and 787 insects are known to be present. In the biosphere reserve nomination 10 species are mentioned as being threatened but they are not identified. Threatened species believed to exist in the region include: one mammal, bushy-tailed hutia Capromys melanurus (I), which is confined to scattered areas among the four most eastern provinces, and two species of birds, Cuban sharp-shinned hawk Accipiter striatus fringilloides (R) and Florida everglade kite Rostrhamus sociabilis plumbeus (R).

**CULTURAL HERITAGE** Zones of historical value connected with armed insurrection and French settlements during the Haitian emigration in the last century are studied and preserved.

**LOCAL HUMAN POPULATION** The buffer zone of 49,140ha supports a population of 28,000. The largest settlement has 640 inhabitants and 21 villages have more than 200 residents.

**VISITORS AND VISITOR FACILITIES** Tourism is permitted and there is a recreation centre. There is provision for various student training activities. The Commission of the Environment and Natural Resources has encouraged student activities concerned with the environment and pollution. Transport and guides are provided by the authorities.

**SCIENTIFIC RESEARCH AND FACILITIES** Baconao has been of interest to scientists for a long time, an important pioneer being the collector Charles Ransteden. Over the last decade more than 80 studies, mostly concerned with the composition and distribution of ecosystems (fauna, flora, vegetation, climate, soil), have been undertaken. The area has various scientific installations, such as meteorological radar, a pluviometric network, satellite tracking, solar energy centre, silviculture study centre, underground laboratory, and a seismological, geophysical and astronomical station. There is an herbarium and wood collection. An ecology station is being built.

**CONSERVATION MANAGEMENT** It is not clear why the area was nominated as a biosphere reserve, but the area is known to be relatively unspoilt. Hatibonico Wildlife Refuge lies within the area (Perera and Rosabal, 1986) but information regarding its size and exact location is lacking. A system of zonation has been implemented based on the biological value of areas and human population density. The areas given most protection, including prohibition of all human activity, are those that support primary vegetation. There are four zones: Seccion el Indio, a strip no more than 4km wide running 40km along the coast from the western end of the coastal boundary and covering an area of 14,200ha  $\pm$  150ha; Seccion Morrillo, which runs the remaining distance along the coast but extends further inland, up to 12km, and covers an area of 14,800ha  $\pm$  150ha; Seccion Gran Piedra, which contains the highest land and covers 13,300ha  $\pm$  150ha; and an unnamed zone of 42,300ha  $\pm$  150ha which surrounds the Seccion Gran Piedra. A general management plan exists which is intended to encourage the harmonious integration of nature reserves with the construction of roads, hunting, villages and technical and scientific development.

**MANAGEMENT CONSTRAINTS** During the last century several North-American companies mined open-cast for iron, as a result of which large areas are devoid of vegetation cover. This coincided with the clearing of mountain forests to make way for coffee plantations set up by French colonists. More recently during the

1940s large areas were dug up for carbon. Present problems include pressures from livestock and wood clearance. It is not clear what form these pressures take. STAFF One hundred and forty three people work in the reserve, including five administrators with university education.

BUDGET No information

LOCAL ADDRESSES Plan Baconao Esfera de Areas Protegidas, Calle 13 #256 - Vista Alegre, Aptdo. 335, Santiago de Cuba

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## CUBA

NAME Cuchillas del Toa Biosphere Reserve

IUCN MANAGEMENT CATEGORY Cupeyal del Norte: I (Strict Nature Reserve)  
Whole area : IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 8.39.13 (Cuban)

GEOGRAPHICAL LOCATION Situated in the most eastern region of Cuba and extends over parts of Sagua de Tanamo, Moa, Yateras and Yunque de Baracoa municipalities. Yunque de Baracoa National Monument lies 5km to the south-east. The reserve boundaries are to the south and south-west the Toa River; to the north Moa, Arroyon and Jiguani Rivers; to the north-east the coastline; and in the south-east corner the Duaba River. 20°16'-20°35'N, 74°30'-75°08'W

DATE AND HISTORY OF ESTABLISHMENT Protection is based on legislation No.33/81 of 12 February 1981. Accepted by Unesco as a biosphere reserve in October 1986.

AREA 127,500ha

LAND TENURE State

ALTITUDE 0-1,139m

PHYSICAL FEATURES Orographically, the reserve belongs to the Sagua-Baracoa mountain and includes Cuchillas de Moa, Cuchillas del Toa and Alturas de Baracoa. Stratigraphically, it is one of the oldest areas in Cuba, with outcrops of Lower-Middle Jurassic (terrigenous clastic-metamorphic) and Upper Cretaceous (terrigenous clastic, carbonate, volcanoclastic) rocks. Predominant in the area are Mesozoic igneous rocks, both ultrabasic (peridotite serpentinite) and basic (gabbro, dolerite) and those of Paleocene, Oligocene and Eocene periods. From a geomorphological point of view the reserve consists principally of eroded tectonic blocks, which correspond to deeply dissected medium-height mountains between 500 and 700m.

CLIMATE Cuba is affected by the Gulf Stream and the north-east trade winds. The heaviest rain falls in September and October and the hurricane season is between June and November. The reserve experiences an "entermaxerico" equatorial humid climate and an annual temperature range of 23.0-27.5°C. Annual precipitation ranges from 3000mm to 4000mm.

VEGETATION Biogeographically Cuba is a province, with flora specifically related to that of the Amazon. There are more than 2,000 species of vegetation, of which more than 100 are locally endemic (e.g. Calophyllum utile, Aristida pradana, Hemithrinax rivularis, Epidendrum replicatum). Principal types of vegetation are montane rain forest (pluvial), xeromorphic matorral (charrascal or brenal) and pine Pinus cubensis.

FAUNA The fauna is probably the richest in abundance, as well as diversity, in Cuba. Amongst the most important vertebrate species are the Cuban solenodon Solenodon cubanus (E), an insectivorous mammal and living fossil. Also present are the bird species: ivory billed woodpecker Campephilus principalis (E), Cuban crow Corvus nasicus, Cuban Amazon Amazona leucocephala leucocephala, and Cuban conure Aratinga euops which is locally endangered. There are numerous species of

noteworthy insects and representatives of the mollusc genus Polymita.

CULTURAL HERITAGE No information

LOCAL HUMAN POPULATION Rural populations in the area are small, with a population density of between 10 and 30 inhabitants per sq.km.

VISITORS AND VISITOR FACILITIES Tourism is permitted.

SCIENTIFIC RESEARCH AND FACILITIES Surveys of fauna, flora, vegetation, climate, geology and soil have been undertaken. Further work is planned from 1987 to add to the existing knowledge of fauna, flora and ecosystems.

CONSERVATION VALUE The importance of the area lies in the richness of species present, including several nationally threatened species.

CONSERVATION MANAGEMENT No management plan exists. Protection is principally directed towards the fauna and forest areas. There are seven core zones surrounded by a buffer zone. Six of them, Cupeyal del Norte, El Toldo, Jaguani, Alto de Iberia, Pico Galan and Rio Toa, border each other and cover an elliptical shape 60km by 30km. To the south-east is El Yunque core zone which is separated from the others by the buffer zone along the Toa River. The buffer zone is usually no more than 2-3km wide.

MANAGEMENT CONSTRAINTS No information

STAFF Totals 35 including forest guards and wardens. Two staff have an university or equivalent education.

BUDGET No information

LOCAL ADDRESSES Instituto de Botánica ACC, Calzada del Cerro 1257, Gaveta Postal 20006, Ciudad de Habana

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## CUBA

NAME Guanahacabibes Peninsular

IUCN MANAGEMENT CATEGORY

El Veral and Cabo Corrientes: I  
(Strict Nature Reserves)  
Whole area: IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 8.39.13 (Cuban)

GEOGRAPHICAL LOCATION Occupies the extreme west of the Cuban archipelago. It is bounded to the north by the Gulf of Guanahacabibes, to the west by the Yucatan Straits, to the south by the Bay of Corrientes and the Caribbean and to the east by the La Fe to La Güira road. 21°46'-22°02'N, 84°10'-84°56'W

DATE AND HISTORY OF ESTABLISHMENT Legislation that protects the area is in the form of Law No. 33/81. Cupeyal del Norte and Jaguani Nature Reserves, which are included in the area, were established on 10 July 1963 under Resolution No. 412 in the Gaceta Oficial. The area was accepted by Unesco as a biosphere reserve in October 1986.

AREA 101,500ha

LAND TENURE State

ALTITUDE 0-25m

PHYSICAL FEATURES The karst peninsular of Guanahacabibes is one of the youngest geological areas of Cuba. The area consists of a carsic plain with numerous limestone protrusions known as "dogteeth". The freatic layer lies a few metres below the surface and the region has no mountain "macizos" nor rivers. The rocks in two-thirds of the area are Pleistocene (alluvial muds, carbonates) and the remainder Holocene (reefs, peat and alluvial sediment). The northern part is lowest with swamps and mangroves. In the north is a 60km fringe of marine plain with marshy lakes; in the northeast are swampy fluvio-marine delta plains; the remainder of the reserve includes erosional and depositional marine plains which are somewhat dissected.

CLIMATE Mean annual temperature is 25.9°C and mean annual precipitation is 1460mm at an altitude of 10m.

VEGETATION The flora has a biogeographical affinity with the Yucatan. Principal types are semi-deciduous forest, swamp and coastal (sandy, rocky and mangrove). Cultivations of tobacco, fruit and pastures are present. More than 500 plant species have been collected. The semi-deciduous forest has the highest degree of endemism in Cuba. Included among the 13 endemics on the peninsular are Byrsonima roiqii, Callicarpa roiqii, Eugenia roiqii, Galactia acuneana, Goerziella minima and Neobrcea angustifolia.

FAUNA Notable mammals include Desmarest's hutia Capromys pilorides and prehensile-tailed hutia Capromys prenensilis. Birds include white-tailed dove Columba leucocephala and bee hummingbird Mellisuga helenae. Of reptiles Cuban tree boa Epicrates angulifer (I) and Cuban ground iguana Cyclura nubila (V) and various species of anole Anolis spp. are present. Little is known about the invertebrate fauna.

CULTURAL HERITAGE No information

LOCAL HUMAN POPULATION Population density is low, with less than 10 inhabitants per sq.km and a low growth rate over the last 10 years. Human activities are restricted to fishing and apiculture.

VISITORS AND VISITOR FACILITIES No information

SCIENTIFIC RESEARCH AND FACILITIES Until 1987 no detailed botanical survey had been carried out. Research has been conducted to establish the impact of mammals, especially hutias and spiny "Jibaros", on the environment. In 1987 an integral study of flora and fauna and various ecological studies will be started, with the intention of establishing a more complete picture of the natural resources by 1990.

CONSERVATION MANAGEMENT Vegetation in the reserve is in an unspoilt condition, especially in El Veral and Cabo Corrientes, which have been isolated from human activity since 1963. The core zone of 62,200ha is divided into three sections for scientific study: El Faro (21,500ha), El Veral (18,600ha) and Cabo Corrientes (22,100ha). The unnamed buffer zone of 39,300ha is in the form of a substantial area to the east, but in strips and 'corridors' to the west. This effectively separates the core zones from each other and excludes a 66km strip of south coastline from the core zone. The buffer zone contains the major communication routes and most settlements of the area. The forest is managed within the buffer zone. There are several small settlements within the Seccion el Faro core zone. The activities of the local population are not considered a threat to the reserve. Two wardens are employed to guard El Veral and Cabo Corrientes zones, and guards from the Department of Flora & Fauna of the Ministry of Agriculture also protect the reserve. Protection and scientific work will be increased from 1987 when the management plan will be prepared.

MANAGEMENT CONSTRAINTS Attention is being paid to identifying destructive activities so that measures can be taken to halt them.

STAFF 24

BUDGET No information

LOCAL ADDRESSES Instituto de Ecología y Sistemática, Calzada del Cerro 1257, Gaveta Postal 20006, Ciudad de La Habana

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## CZECH AND SLOVAK FEDERATIVE REPUBLIC

NAME Polana Biosphere Reserve

IUCN MANAGEMENT CATEGORY V (Protected Landscape)  
IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 2.11.05 (Middle European Forest)

GEOGRAPHICAL LOCATION Situated in central Slovakia, in the Banska Bystrica district, centred on the Polana peak. The river valleys of the Hron and the Slatina flow on the western and northern flanks and on the southern flank respectively. The town of Zvolen (37,000 inhabitants) lies 19km away. The territory is part of the Interior West Carpathians, namely two of its geographical regions: the Slovenske Stredohorie Mountains and the Slovenske Rudohorie Mountains. The Rudohorie Mountains comprise the greater part of the Reserve. 48°39'N, 19°29'E

DATE AND HISTORY OF ESTABLISHMENT The reserve was established during 1990. The protected landscape was created on 12 August 1981, by Decree No. 97 of the Ministry of Culture of the SSR. The objective of the decree is the protection and cultivation of nature and natural values, provision for their optimum exploitation with respect to multifunctions in terms of their cultural, scientific, economic, water management and health recreational resources.

AREA 20,079ha: core area 1,238ha, buffer zone 9,650ha, transitional area approximately 9,191ha.

LAND TENURE State: principally national, state and local government. Secondary ownership lies with a cooperative and private holders.

ALTITUDE 460-1,458m

PHYSICAL FEATURES The central part of the reserve is formed by the Kyslinky, an interior depression with an elevation between 650-1,000m, and an average inclination of 8-9°. The depression is surrounded by the Vysoka Polana Mountains, the greater part of which rises above 1,100m and reaches the sub-alpine zone. The whole area of the reserve is contained by the Hron River catchment basin, or component basins of the Cierny, Hron, Slatina and Hutna rivers. From a hydrological viewpoint rivers are of the middle-mountainous type, with the maximum flow from March to May. The western and central parts of the reserve are formed by rocks belonging to the stratovolcanic complex - pyroxenic andesites of the second phase Tertiary volcanics. Lava flows, peripherally transported volcanoclastics and conglomerates form the transitional volcanic zones. In the eastern part Hercynian intrusion, magmatites and subalpine metamorphgites emerge to the surface. Erosion lava sheet and flow debris forms table tops in some places, as well as caldera, belong to this characteristic formation. Forest brown-earth soils dominates in the area. At the highest elevations andesols and andepts have weathered from the parent rock.

CLIMATE Conditions are those of the northern temperate zone, on the transition between the oceanic and continental climates. Westerly winds dominate in the area, and frequent air mass changes create a great diversity of meteorological elements. Average temperatures vary from 11.5-13.5°C in July to -6 or -7°C in January. Precipitation varies from 561mm at 386m to 912mm at 1,300m.

VEGETATION The temperate forest cover changes with altitude from oak-hornbeam Quercus sp.-Carpinus betulus groves through beech Fagus sylvatica and silver fir Abies alba groves to maple Acer platanoides mountainous forests and spruce Picea sp. groves. Deforested areas with grass meadows occur on the foothills of the mountain range. The following species have been recorded: Viola lutea ssp. sudetica, Hesperis nivea, Crocus heuffelianus, Trollius europaeus ssp. europaeus, Aquilegia vulgaris.

FAUNA Mammal species recorded include brown bear Ursus arctos, lynx Lynx lynx and others such as Microtus agrestis and Sorex alpinus. Breeding birds include capercaillie Tetrao urogallus, spotted eagle Aquila clanga, eagle owl Bubo bubo, ring ouzel Turdus torquatus and three-toed woodpecker Picoides tridactylus. Amphibians and reptiles are represented by Lacerta vivipara, Triturus alpestris and Rosalina alpina.

CULTURAL HERITAGE Historical monuments are found in the area.

LOCAL HUMAN POPULATION Approximate population density is 25/sq.km. Those within the reserve mainly practise pastoralism or other forms of agriculture. No-one lives within the core area. However, 100 people live in the buffer zone and 900 in the transition zone on a permanent basis.

VISITORS AND VISITOR FACILITIES Facilities for tourists include interpretive programmes and environmental education for school children and students.

SCIENTIFIC RESEARCH AND FACILITIES Research activities include: agriculture, rural technologies, flora and fauna surveys, biochemical system studies, ecological comparison and succession, ecosystem modelling and restoration; atmospheric and waterbourne pollutant effects, geomorphology, forest research, limnology and hydrobiology, rare species, resource mapping, soil studies, and wildlife population dynamics. Research facilities include a climate monitoring station, a library, lodging for eight visiting scientists, and permanent vegetation monitoring plots. In the future three fully equipped field stations will be built. Laboratory work can be carried out in the Forestry and Wood Technology University, and in the Forest Ecology Institute, Slovak Academy of Sciences, in Zvolen.

CONSERVATION VALUE Species of particular conservation value include many listed in the Czechoslovak Red Data Book. However, a final list for the site has yet to be drawn up. Valued habitat areas include: Zadna Polana, with a primeval Norway spruce population; Hroncecky Grun, containing 400-year old fir and spruce of great size; Lubietovsky Vapor, an area of primeval fir-beech forest with nesting birds of prey; Pod Dudasom in the Hucava Valley; Vodopad Bystre waterfall and Kalamarka, where rock faces are populated by endemic, and mediterranean and thermophilic species.

CONSERVATION MANAGEMENT Within the protected landscape there are four national nature reserves, the largest being Polana (685ha) and six protected natural features. Existing land-use and management plans are: regional land-use plan containing general principles of maintenance of physical and biotic environment, and proposing rational use of natural resources; regional plan of State Nature Conservancy containing detailed projects of conservation activities; preventive safeguard of State Nature Conservancy for the Banska Bystrica district.

MANAGEMENT CONSTRAINTS No major threats reported.

STAFF Three professionals worked in the protected landscape. The biosphere reserve may have a staff of five, plus an extra 43 for research and education roles.

BUDGET Annual operating budget is approximately 200,000-300,000 Kcs.

LOCAL ADDRESSES Sprava Chranenej Krajinnej Oblasti Polana, Hurbanova ul. 20, Zvolen CS 960 01

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## CZECH AND SLOVAK FEDERATIVE REPUBLIC

NAME Sumava Mountains Protected Landscape Area

IUCN MANAGEMENT CATEGORY V (Protected Landscape)  
IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 2.32.12 (Central European Highlands)

GEOGRAPHICAL LOCATION Situated in south-west Bohemia, along the border with Germany and Austria in the Bavarian-Sumava Forest. It extends some 90km from Nyrsko in the north-west to Nova Pec in the south-east. 49°01'N, 13°34'E

DATE AND HISTORY OF ESTABLISHMENT The area, the largest protected area in the country, was created on 27 December 1963 by Decree No. 53.855/63 (although parts of the area have been protected for much longer). This decree aims to preserve and enhance the quality of the landscape and to control its development. The core and buffer zones are legally protected in national and state legislation by means of administrative regulation, executive decree and ownership rights. Local legislation, cooperative agreements and voluntary designations also play a part. Areas of natural forest are protected by law, others managed by the Forestry Service which controls logging activities. In 1975 a decree of the CSR Ministry of Culture "Of a new legal arrangement of the Sumava Protected Landscape Area" was passed (Vynos MK CSR c. 5954/1975). The reserve was accepted as a biosphere reserve in 1990.

AREA 167,117 ha (a number of core zones totalling 42,224ha, a buffer zone of 68,893ha and a transition zone of 56,000ha)

LAND TENURE National, state and local governments, with secondary ownership in by private individuals, corporations of groups, as well as university and research institutions.

ALTITUDE 470-1,378m (Plechý). Several peaks reach 1,300m and higher (for example, Jezerní hora, Plesná and Trojmezna hora)

PHYSICAL FEATURES Comprises an extensive, geographically homogenous mountain area which is a continuation of the Böhmerwald in Germany. The substrates consist of granitoids of different types and rocks are mainly crystalline schists, with smaller areas of crystalline limestones and quartzite dykes. Most of the mountains have the geomorphological pattern of a peneplain dissected into broad ranges with flat tops and form the continental divide between the Danube and Elbe river systems. In the Pleistocene, Sumava was partly covered by small glaciers. Five lakes, totalling 42ha, most of them protected as nature reserves, remain as the evidence of glaciation, together with some glacial scree. In addition, there is a large artificial reservoir, the Vodní nádrž Lipno, in the south, as well as a canal which skirts the Pieky and Smrcina peaks. The site lies largely in the catchment of the Vltava (Moldau) River. Soils are represented by brown forest podzols and various types of peat.

CLIMATE Central European temperate, with characteristics of mountainous areas exhibiting a gradient between sub-atlantic and sub-continental systems. Maximum average temperature is 17°C at 470m, and -5.2°C recorded as the minimum average at 1,351m. Mean annual precipitation is 1100mm at 1,000m.

**VEGETATION** Sumava is more or less completely covered with forests. There are three main habitat types: montane raised peatbogs of Pino rotundatae-Spagnetum community, representing the most natural edaphic climax type in the area, devoid of human influence and containing relict populations and endemic races of flora and fauna; natural, semi-natural and planted forests consisting of isolated pockets of mixed beech-spruce-fir forests dominated by Fagus sylvatica, Picea abies and Abies alba, montane climax spruce forest (community of Piceetum hercynicum) and forest plantations of Picea abies (78% of forests); montane grasslands maintained by traditional farming activities containing heterogenous communities of diverse flora (Polygonum bistorta, Cissium heterophyllum and Gentiana pannonica). Rowan Sorbus aucuparia and maple Acer platanoides also occur here and locally there are isolated growths of mountain pine Pinus mugo. Boubinsky Prales Nature Reserve is well known as an area of virgin forest, as is the area between the Cerne and Certovo lakes. A very characteristic component of the landscape are peat bogs such as that within Jezerni Slat nature reserve. Here, at an altitude of over 1,000m, is a raised peat bog with characteristic species such as Eriophorum vaginatum, Carex spp., Sphagnum spp., and on drier sites dwarf birch Betula nana. The following important plant species should also be mentioned: Aconitum variegatum, A. napellus, Arnica montana, Blechnum spicant, Calla palustris, Campanula glomerata, Cephalanthera alba, Daphne mezereum, Dianthus superbus, Doronicum austriacum, helleborines Epipactis latifolia, E. atrorubens and E. palustris, Gentiana pneumonanthe, G. crudiata, G. Pannonica, Gentianella ciliata, Gymnadenia conopsea, Chamaebuxus alpestris, Ledum palustre, Lilium bulbiferum, L. martagon, Menyanthes trifoliata, Mulgedium alpinum, Platanthera bifolia, sundew Drosera rotundifolia, and Soldanella montana.

**FAUNA** Once the Sumava woods were the natural habitat of European bison, brown bear, wolf and lynx. Today, of the larger mammals only red deer Cervus elaphus and lynx Lynx lynx live here. Northern birch mouse Sicista betulina is a glacial relict, and Alpine shrew Sorex alpinus pre-glacial. Otter Lutra lutra is rare. Eagle owl Bubo bubo, pygmy-owl Glaucidium passerinum and Tengmalm's owl Aegolius funereus breed, as well as three-toed woodpecker Picoides tridactylus, nutcracker Nucifraga caryocatactes, ring ouzel Turdus torquatus and several grouse species such as capercaillie Tetrao urogallus, hazel hen Tetrastes bonasia and black grouse Lyrurus tetrix. The two lakes within Cerne and Certovo Jezero Nature Reserve are extremely oligotrophic, but they have a characteristic fauna.

**CULTURAL HERITAGE** No information

**LOCAL HUMAN POPULATION** There are a large number of villages and settlements in the area, the largest being Volory in the south-east. The nearest large town is Ceske Budejovice (population 96,000), some 40km to the east, whilst Plzen (population 175,000) lies 55km to the north. The population density of the region is 1.5/sq.km. The local population is predominantly agricultural and urban. Within the core zone, there are 60 permanent inhabitants, 1,640 in the buffer zone and 22,900 in the transitional zone. The local population benefits from access to employment opportunities, rural development assistance, recreation and tourism. Grasslands, oat and potato crops are currently planned. Grazing cattle is the chief husbandry activity..

**VISITORS AND VISITOR FACILITIES** The area is used extensively and intensively for both summer and winter recreation. There are many hotels, trade-union and other organisation-owned hostels and camping sites. The annual number of visitors is around 1,000,000.

**SCIENTIFIC RESEARCH AND FACILITIES** Some 35 national scientists work at the site,

together with 5 visiting scientists from abroad. The site is also being studied as part of the international acid rain monitoring project and comparative studies of boreo-alpine insects of north and central European peatlands. Applied and integrated research programmes exist. Research has been continuing into the hydrobiology of Cerne and Certovo lakes since 1897. Resources available include mapped information (vegetation cover, topography, geology, soil), four topics in the aquatic field, atmospheric data, a complete set of biological inventories and socio-economic and cultural data. There are 19 past and on-going research activities. Facilities include an air pollution monitoring station, climatological station, conference facilities, lodging for 20 visiting scientists, logistic support and permanent monitoring plots. There is close association with the Academy of Sciences, South Bohemian Biological Centre.

CONSERVATION VALUE Particularly important habitat types are represented by montane raised and valley peatbogs and montane natural forests. Ten floral and faunal species present appear in national Red Data Books and a further 12 species are considered to be endangered or threatened at national or regional level.

CONSERVATION MANAGEMENT Ten nature reserves are located within the area: Bila Strz, Cerne a Certovo jezero (152 ha), Jezerni slat (120 ha), Mlynarska slat, Rokytske slat, Rokytske slat, Bukova slat, Lipka, Boubinsky prales (666ha), Mrtvy luh (283ha) and Trojmezna hora (386ha). The area abuts Bayerischer Wald National Park in Germany, as well as the Naturpark Oberer Bayerischer Wald and the Naturpark Bayerischer Wald. The site has some 13 existing cooperative and coordinative links, the most important being cooperation with the regional planning and development authorities and the local communities, and coordination of comparative long-term monitoring and research programmes. School children, students, local people, graduates, post-graduates and tourists benefit from environmental education. Professional training is undertaken and workshops are held for staff and resource managers. Key activities in the core zone include environmental education, training and research. Public recreation, authorised fishing and hunting also take place, although not at a level to cause concern. Agricultural activities, forestry, grazing, hunting, recreation and tourism are undertaken in the buffer zone. In the transition zone, a range of activities including agriculture, forestry, gathering of natural products, grazing, human settlement, hunting, recreation and tourism occurs. A management plan exists in the form of the landscape plan of the Sumava region (Terplan, Prague, 1969) accepted by the government by Decree No. 155/1969. There is also a separate land use plan for Sumava Landscape Area (Terplan, Prague, 1989).

MANAGEMENT CONSTRAINTS The area is under a similar high threat from air pollution as the adjacent Bayerischer Wald National Park, where a 1987 study showed that more than 50% of the conifer trees have already been damaged by 'acid rain' air pollution (Bibelriether, 1984; Bibelriether, *in litt.*, 1988). Under greatest threat are the conifers including Norway spruce and the uncommon mountain pine, although peatbog communities are also in danger from increased acidification. The agents mostly responsible for the pollution are presumed to be sulphur dioxide and the nitrogen oxides emitted by industrial works in Germany and Czechoslovakia. The mountain crest forests are the most vulnerable to pollution due to their high level of exposure to wind-blown pollutants (Bibelriether, 1984; Bibelriether, *in litt.*, 1988). Further damage may be caused by forestry and agricultural activities which are not controlled except, apparently, in the nature reserves. There is a particular threat to montane grasslands.

STAFF Totals 20 of which 10 are university-trained. In addition, there are 3 education officers.

BUDGET Koruna 1,000,000 provided by a single, central administrative authority.

LOCAL ADDRESSES Regional Centre for Care of Historical Monuments and Nature Conservancy (Krajske stredisko statni pamatkove pece a ochrany prirody) Zizkovo nam 14, CESKE BUDEJOVICE CS 37021 (Tel: 038 36903) for Sumava CHKO West Bohemian Centre, Regional Centre for Care of Historical Monuments and Nature Conservancy (Krajske stredisko statni pamatkove pece a ochrany prirody), Dominikanska 4, PLZEN (for western part)

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## ECUADOR

NAME Yasuni National Park and Biosphere Reserve

IUCN MANAGEMENT CATEGORY II (National Park)  
IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 8.05.01 (Amazonian)

GEOGRAPHICAL LOCATION Situated in the Amazonian region, Napo Province in the north of the country. Its northern and southern limits are Rio Napo and Rio Yasuni, respectively. The town of Francisco de Orellana, more commonly known as Coca, is about 45km from the reserve. 0°26'-1°08'S, 75°25'-76°40'W

DATE AND HISTORY OF ESTABLISHMENT Established as a national park on 26 July 1979 under Agreement No. 322 published in the Official Register No. 69 of 20 November 1979. Its nomination as an international biosphere reserve was approved by the MAB Bureau in 1989.

AREA 679,730ha

LAND TENURE Government

ALTITUDE 300m-400m

PHYSICAL FEATURES It is the largest national park in the country. Main rivers crossing the reserve are the Tiputini, Yasuni and Nashiño; nearby rivers include Napo, Cononaco and Curaray. The terrain is very sinuous, despite of being in the Amazonian plains. With the exception of Rio Napo which originates in the foothills of the Andean Cordillera, rivers crossing the national park originate at altitudes from 300m to 600m (Anon., 1988). The topography is represented by low plains alternating with hills which rise more than 10m above the level of the river. It forms part of the foothills of the Andean chain and is represented by a softly inclined platform which is supported by the Guyano-Brazilian shield that extends from Vaupes in the south of Colombia to the Arco de Contaya in Peru. Soils are very shallow and poor and mainly consist of red clay (Anon., 1988).

CLIMATE Conditions are tropical with a dry season from late December to March, a rainy season from April to July and a fluctuating season lasting from August to mid-December. Climate is very variable due to proximity to the Cordillera de los Andes (Andean Cordillera). Mean annual temperatures range from 12°C to 38°C; mean annual rain is 3,500mm at an altitude of 320m, with 9 to 10 wet months in the year; mean annual relative humidity ranges from 38% to 100% (Anon., 1988).

VEGETATION Contains elements of both the south-west Amazon and the Solimoes-Amazons phytogeographical regions. Three main types of vegetation occur: 'Terra firme', found on the high reliefs, areas and not subjected to flooding; 'Varzea' a forest type subject to periodic flooding and 'Irapó' in the permanent or near permanent flooded forest. Moist tropical forest include species such as Macrolobium acaciifolium, Coussapoa trinervia, Licania sp., Eugenia sp., Bactris sp., Astrocaryon sp., Mauritia flexuosa, Vismia baccifera, Guarea sp., Nectandra cf. reticulata, Cedrelinga cataeformis, Ochroma sp. and Pouteria sp. (Anon., 1988).

FAUNA Representative mammals include Brazilian tapir Tapirus terrestris, collared



peccary Tayassu tajacu, woolly monkey Lagothrix lagothricha (V), long-haired spider monkey Ateles belzebuth (V), brown pale-fronted capuchin Cebus albifrons, monk saki Pithecia monachus, giant armadillo Priodontes giganteus (V), agouti Dasyprocta sp., paca Cuniculus paca, capybara Hydrochoeris hydrochaeris, two-toed sloth Choloepus sp., three-toed sloth Bradypus sp., southern coati Nasua nasua, jaguar Panthera onca (V), puma Felis concolor, ocelot F. pardalis (V), jaguarundi F. yagouaroundi (I), margay F. wiedii (V), giant otter Pteronura brasiliensis (V), red brocket Mazama americana, brown brocket M. gouazoubira, Amazonian manatee Trichechus inunguis (V) and bottlenose or Amazon river dolphin Inia geoffrensis (V). Amongst the avifauna, harpy eagle Harpia harpyja (R), curassow Mitu selvini and white-browed guan Penelope jacucaca are found. Reptiles include boa Boa constrictor, South American river turtle Podocnemis expansa (E), yellow-footed tortoise Geochelone denticulata, spectacled cayman Caiman crocodylus (T), dwarf cayman Paleosuchus palpebrosus and black cayman Melanosuchus niger (E). Fish include pirarucu Arapaima gigas (V) (Anon., 1988).

**CULTURAL HERITAGE** Cononaco is traditionally a settlement area for indigenous communities such as the Huaorani or Aucas and Quichuas. Huaoranis are nomads who inhabit the basins of the rivers Curaray, Cononaco, Tigüino, Shiripuno, Yasuni and Nashiño; the Quichuas permanently inhabit the riverbanks of the Napo river. Spontaneous settlements also exist in the areas surrounding the reserve as well as in the basins and sub-basins of the Napo and Cononaco rivers. The reserve has been proposed as a Cultural Heritage area due to the presence of various Huaorani groups inside and outside the reserve (Anon., 1988).

**LOCAL HUMAN POPULATION** Some Huaoranis inhabit the core area. There are 75-80 people in the core zone, 2,500 in the buffer area and between 4,000 and 5,000 in the transition zone; the maximum population density is two inhabitants per sq. km. The following plants have been used traditionally by the indigenous people who are mainly nomadic: Mauritia sp., Phytelephas sp., Oenocarpus sp., Inga sp., Gynerium sagittatum, Musa sp., Manihot esculenta, Ipomoea sp., Dioscorea sp., Xanthosoma sp., Arachis hypogaea, Zea mays, Saccharum officinarum, Ananas sp., Carica papaya and Guilielmia sp. Domestic animals kept by the Indians include pigs, chickens, cattle, horses, guinea-pigs and rabbits. Main activities are agriculture (coffee, bananas, yuca, paw paw, citrus fruit, maize and achiote), fishing, forest dwelling, hunting and gathering forest products (Anon., 1988). Some squatters from other parts of the country are in the reserve now (Anon., 1988). There are 25,000 inhabitants in the town of Francisco de Orellana.

**VISITORS AND VISITOR FACILITIES** Main access to the reserve is by boat along the Napo river. There is access by road and air to Francisco de Orellana where a boat can then be taken to various points. About 1,000 people have visited the reserve each year (Anon., 1988), but the potential for tourism is considerable and therefore, encouraged (Anon., n.d.). There are information services for the local population, research projects for university students and workshops for administrators and planners on resources and protected areas. Planned activities include environmental education for schools and tourists and professional and scientific workshops (Anon., 1988).

**SCIENTIFIC RESEARCH AND FACILITIES** Eight national and four foreign scientists participate in research. There is an International Development Agency (IDA) agroforestry project in Francisco de Orellana which aims to demonstrate land and resource use to the settlers and Indians. Under this project, small areas are being re-forested with pachaco, laurel and jacarandas. Activities carried out include aerial photography, topographic and resource mapping, hydrology, climatology, species inventories, geology and ethnobiology. Past research

includes agriculture, aquaculture, biological sampling, anthropology, exotic species, soils and traditional land-use systems. Ongoing research includes agriculture, biological sampling, bioenergetics, comparative ecology, anthropology, ecological succession, pollutants, ethnobiology, exotic species, fish population dynamics, forestry, genetics, geomorphology, limnology, pests and diseases, pastures, threatened species, resource mapping and social sciences. New planned activities include acid deposition, ecological modelling, ecosystem restoration, pesticides, tourism and recreational impacts, sedimentation, research on basins and population dynamics of wildlife. A Regulating Plan for the basin of the river San Miguel, including the Napo river and a study of the Ecuadorian Flora (with participation of the universities Aarhus-Denmark and Missouri) were carried out between 1978 and 1986. Geological studies by some oil companies such as CONOCO, ELF and CGG (France) and BRASPETRO (Brazil) have been done, as well as studies on potential mining, oil and timber in Napo Province where the national park is situated (Anon., 1988).

Facilities include a climate monitoring station, a library and a laboratory. Up to six visiting scientists can be accommodated. There are research vehicles, permanent monitoring of rivers, vegetation and storage facilities for scientific collections. A biological station inside the park was planned in 1988. Nuevo Rocafuerte, a research institution in the north-east boundary of the nearest national park to Peru, is the closest research station to the reserve. A professional exchange programme exists with the Galapagos National Park (Anon., 1988).

CONSERVATION VALUE To protect the hydrological basins rich in wildlife and natural resources and its traditional indigenous communities.

CONSERVATION MANAGEMENT The objectives of the biosphere reserve are to to conserve natural ecosystems, to provide protective legislation, in situ conservation of specific genetic resources, research towards conservation, long-term vigilance, encourage regional planning and rural development, encourage local participation in land use and environmental education. The natural resource inventory would serve for the zonification of the reserve in the management plan (Anon., 1988). A draft management plan was funded by Conoco Oil, which has concessions in the reserve (Read, 1989). There is cooperation between the reserve's administration and the national MAB committee, local authorities, communities and institutions. There are settlers and Indians in both the agroforestry project (where there are experimental demonstration plots) and in the applied research projects (Anon., 1988). In 1987, Ecuador started a debt swap for nature programme from which Yasuni will benefit (Anon., n.d.). Hunting, fishing and wildlife trade controls exist as well as professional park ranger patrols which give support to the indigenous communities (Anon., 1988). Activities in the buffer and transition zones include agriculture, biological inventories, scientific collections, environmental education, fishing, collection of natural products, long-term monitoring, professional training, tourism, housing developments, habitat restoration, wetland restoration, urban centres and hydrological projects (Anon., 1988).

MANAGEMENT CONSTRAINTS It is believed that legislation is poorly enforced (Scott and Carbonell, 1986). Both in the buffer and in the transition zones, the following activities occur to a greater or a lesser extent: wetland and terrestrial habitat destruction, human settlements, hunting, industrial developments, oil and gas exploitation, poaching (hunting and fishing) and mining. The transition zone is also used for pasture land such as cattle, pig and sheep ranching for family subsistence; pasture lands are made up of 'gramalote' and

elephant grass. This area is occupied by settlers and Indian communities, such as on the riverbank of the Rio Napo from Francisco de Orellana to Nuevo Rocafuerte and the roads Los Aucas and Yucas which go in a south-east direction (Anon., 1988).

Large scale oil and gas exploration is taking place in the whole of the Oriente region where oil companies are causing forest destruction and displacing the Indians. Within the biosphere reserve, Conoco Oil has a concession in Yasuni and funded a draft management plan for the reserve which zones more than half of it for industrial use. The plan also anticipates large-scale petroleum exploration as well as mining. In 1989, there were already reports that large scale deforestation was occurring. There are also plans to build another road into the park (Read, 1989). Oil exploration and its associated road network has opened the area for colonisation. In 1986, settlers were reported to have formed organisations to pressurise the government into declassifying parts of the area for settlement. The Department of National Parks appeared powerless to prevent this (Scott and Carbonell, 1986). Settlers are fast coming to the areas cleared by the oil companies for exploration, with the inevitable consequences for the Indians such as disease and land displacement (Read, 1989).

Wildlife trade occurs, with Ara sp. and Harpya harpija sold as pets, while Cebus albifrons, Alouatta seniculus, Lagothrix lagothricha, Ateles belzebuth are sold as pets and for their meat. Arapaima gigas and Agouti paca are sold for their meat (Anon., 1988). Illegal hunting and fishing occurs in the areas of the Yasuni, Tiputini and Cononaco rivers; similar activities, plus selective tree felling in the proximity to military detachments by military personnel, also exist (Anon., 1988).

STAFF Five people in total, two for administration, two for environmental education and one for research (Anon., 1988).

BUDGET In 1988, the annual budget was 3,000,000 sucres. The Agency for International Development (AID) (Agencia Internacional para el Desarrollo) supports a programme for the labelling of Amazonian areas. WWF-US and the New York Zoological Society promised support for 1989 (Anon., 1988).

LOCAL ADDRESSES Direccion Nacional Forestal, Ministerio de Agricultura y Ganaderia, Calle Eloy Alfaro y Amazonas, Quito

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## FRANCE

NAME Réserve de la biosphère d'Iroise

IUCN MANAGEMENT CATEGORY V (Protected Landscape)  
IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 2.09.05 (Atlantic)

GEOGRAPHICAL LOCATION Limited to two sections constituting the Isles of Ouessant (Ushant) and the Archipelago of Molène and their marine environment; centred around the isles and islets of the northern part of the Iroise Sea, located 20km off the coast of western Brittany, in north-west France. All the mainland area of the Parc Naturel Régional Armorique is excluded from the biosphere reserve. The 20m isobath marks the seaward limits of the reserve. The entire archipelago is within the cantons of Ouessant and Saint Renon, Finistère department. Approximately 48°24'N, 4°58'W

DATE AND HISTORY OF ESTABLISHMENT Located within Armorique Regional Nature Park which was created in September 1969 under legislation based on Decree No. 67-158 of 1 March 1967, which was updated by Decree No. 75-983 of 24 October 1975. Iroise was accepted as a biosphere reserve in November 1988.

AREA 21,400ha (50ha core area, 950ha buffer zone and 20,400ha transition zone). The area represents one-third of Armorique PNR (65,000ha).

LAND TENURE Private and public ownership

ALTITUDE From 20m below sea level to 60m at Stiff on Ouessant

PHYSICAL FEATURES The reserve consists of a very varied topography including some of France's most spectacular coastal scenery. It comprises an archipelago of 17 named islands and islets, the largest being Ouessant (1,558ha) followed by Molène, Beniguet and Keller. Ouessant is surrounded by crags and cliffs, those at Stiff being 60m high, although towards the west they are rarely more than 30m and underwater the topography dips sharply, with depths of 90m close inshore. The central part of Ouessant is a depression of micaschists, cut by deep valleys with granite plateaux to the north and south which are incised by many small valleys descending steeply to the sea. The archipelago of Molène comprises the highest points of an enormous submerged plateau area, the whole archipelago being within the 5m isobath. It includes Balanec, a low-lying expanse of rock a few metres above sea-level. Most islands are less than 10m above sea level with only Molène itself reaching 20m. The Armorican massif of the mainland was formed of Precambrian rocks with a covering of Palaeozoic sediments ranging from the Cambrian to the Carboniferous, with a double band of granite-gneiss to the north and south. Ouessant and the archipelago of Molène constitute an extension of the crystalline basement of Léon; the Molène isles, more than the others of the Iroise sea, are clearly extensions of mainland geological formations because of their gneiss substratum and because the granites of the Pierres Noires, of Molène, Balanec and Banneg are extensions of four granitic formations also found on the mainland (Cuillandre, 1988). Underwater channels up to 60m deep occur either side of this archipelago: Les Pierres Noires to the south and La Helle to the north with the Passage of Fromveur between Ouessant and the Molène archipelago. To the north-west of Ouessant is a deep submarine trough, up to 100m below the general level of the sea bed with a maximum depth of 203m which extends for over 16km.

There are two main submarine accumulations of sand, the Banc du Four to the north-east and the Haut-fond d'Ouessant to the south-west.

**CLIMATE** The Atlantic conditions can be extremely variable and there are strong winds of up to 7.1m/sec (locally called Mervert, Kornog and Gwarlarn). The average temperature of the coldest month is 7.7°C and the mean of the hottest month 16.4°C. Annual rainfall averages 699mm at 30m altitude at Ouessant. There are up to 50 days per year of mist and fog (Cuillandre, 1988).

**VEGETATION** A list and details of 411 plant species are available (Cuillandre, 1988). Iroise has 35% of its surface covered by heathland and moors, and there are also bogs and coastal vegetation. The centre and north-east of Ouessant is occupied by humid heath of Calluna and Juncus or xerophilous Juncus and broom. The hilltops usually consist of gorse Ulex and heather communities, with small-scale agriculture dominant in the valleys. Dune formations are uncommon on the isles, the few notable dunes with a specialised flora being found on Banneg and Balaneg. Additional habitats include pebble beach communities of Beta maritima and Crambe maritima (Cuillandre, 1988). Cliff and rock vegetation includes Osmunda regalis, Asplenium marinum, Samolus valerandi and Inula crithmoides. The reserve is noted for the diversity and abundance of its relatively undisturbed marine algae communities, with fronds often of extreme length. Dominant seaweed species include Fucus spiralis, F. vesiculosus and Laminaria digitata. There are extensive Laminaria marine forests extending for 109 sq.km down to 12m depth, an estimated biomass of approximately 70,000 tonnes (Cuillandre, 1988). Threatened plant species include Zostera marina, a species whose distribution is in regression throughout France.

**FAUNA** Large colonies of sea birds nest on many of the islands, including fulmar Fulmarus glacialis, Manx shearwater Puffinus puffinus, as well as raptors such as marsh harrier Circus aeruginosus and Montague's harrier Circus pygargus (a total of 325 bird species is listed in Cuillandre (1988)). Mammals are uncommon, terrestrial species being restricted to otter Lutra lutra and European rabbit Oryctolagus cuniculus, and the endemic subspecies Crocidura suaveolens uxantisi on the isles of Ponant, Banneg and Balaneg. On Ouessant there are colonies of grey seals Halichoerus grypus, at the most southern limit of their distribution, and common seals Phoca vitulina are also seen occasionally in the area. Dolphins Tursiops truncatus and Delphinus delphis have been recorded in the surrounding marine areas. Of the recorded 148 species of fish, notable species include Cetorhinus maximus, Galeorhinus galeus, Mustelus mustelus, Zeus faber and Dicentrarchus labrax (Cuillandre, 1988).

**CULTURAL HERITAGE** The isle of Ouessant maintains a closely-knit farming and fishing community. With a strong Breton culture, place names are still largely of Breton derivation. There are megaliths on the isle of Kemenez and Neolithic and Bronze Age cromlechs throughout the area. Local crafts such as lace-making and hand-carving of sabots are also promoted by the park authorities (Wirth, 1979; Desjeux & Desjeux, 1984)

**LOCAL HUMAN POPULATION** The total number of inhabitants within the park was 160,355 in the 1982 census, with 1,255 on Ouessant alone (Cuillandre, 1988). The economy of the region is based on agriculture (20% of the working population) although many people are also involved in the fishing industry. The main crops are cereals, fodder, fruit and vegetables. Up to 15% of French dairy produce comes from the region. Laminaria digitata seaweed beds in the Molénais plateau are the principal source for the alginate industry in France.

**VISITORS AND VISITOR FACILITIES** There are an average 40,000 visitors annually to

the isles of Ouessant and Molène (Cuillandre, 1988). On Ouessant there is a craft exhibition building. Camping and caravanning sites are maintained by the local communities and in the summer months there traditional festivals are coordinated by the park administration. There is accommodation for 20-35 people at the Centre permanent d'initiation à l'environnement (Cuillandre, 1988).

**SCIENTIFIC RESEARCH AND FACILITIES** The first ornithological surveys were undertaken in 1898 by Clarke and Bureau. The Maritime Biological Association of Plymouth undertook studies in the area from 1920-1940. Work is currently underway at the Centre de la société pour l'étude et la protection de la nature en Bretagne which has functioned since 1984. Its research facilities include a documentation centre for naturalists and researchers and accommodation with 42 beds, as well as a small laboratory, photographic darkroom and lecture room. There is also a permanent ornithological observation centre, created in 1984 for the study of bird migration and changing land-use (Wirth, 1979; Desjeux & Desjeux, 1984; Cuillandre, 1988).

**CONSERVATION VALUE** The immense rocky archipelago represents an unique marine zone largely untouched by man. There is a rich and threatened fauna and flora, with seven fish species on the national red list, eight species of marine bird and a internationally threatened mammal species (Cuillandre, 1988).

**CONSERVATION MANAGEMENT** Hunting is authorised on certain islands but is reserved for native people. Agriculture is permitted and fish are exploited commercially. Seaweed collecting in the *Laminaria digitata* beds, for the alginate industry, is strictly controlled. The site has been well documented by scientists, ornithologists and botanists since the 19th century.

Management of Armorique PNR is undertaken by a board composed of representatives of the municipalities, the departments and professional organisations. They delegate duties to a director who is in charge of day-to-day administration. The park authorities emphasise the active conservation of the natural heritage rather than turning the park into a vast static zoo or museum, and have a special development plan aimed at maintaining and preserving the traditional landscape, which is codified into a charter. The serious problems of rural decline are being counteracted by active promotion by park authorities of traditional crafts and the encouragement of traditional building methods and styles, as well as sponsoring new trades in association with the Chamber of Commerce (DATAR). The management authority has no regulatory powers but deals with protection of natural resources, development of the economy, education of the public and directing visitors to possible activities. Stimulus and enthusiasm for the park is generated at regional 'department' level, but most decisions have to be implemented by the rural communities themselves. Activities ranging from landscape protection to tourism promotions tend to be organised by local associations or cooperatives (Desjeux & Desjeux, 1984; Cuillandre, 1988).

**MANAGEMENT CONSTRAINTS** Pollution in the past included severe oil spills from the wreck of the Amoco-Cadiz in 1978, followed in 1988 by the Amazzone. To-day, one of the greatest problems is widespread commercial overfishing using new techniques and equipment. Large areas of heath were burnt in 1984 and there continues to be excessive erosion of dunes by rabbits and gulls. In 1985, there was extensive destruction of the cliffs in preparation for the construction of the port of Stiff at Ouessant (Cuillandre, 1988). Also in 1985 threats included extraction of rock blocks at Molène for the construction of a dyke. Since 1985 the seaweed collectors have proposed to harvest at greater depths, a proposal which could adversely affect the ecosystem (Desjeux & Desjeux, 1984; Cuillandre, 1988).

**STAFF** Two permanent staff and two part-time employees, one responsible for research (Cuillandre, 1988)

**BUDGET** The management charter is accompanied by a budget covering investment and operating costs. The cost of the park's facilities is borne by local communities assisted by normal state subsidies. The Department of Finistère bears all the capital costs for Armorique PNR and 70% of the running costs, the balance coming from 27 constituent rural communes which contribute 20%, and the City of Brest giving the remaining 10% (Desjeux & Desjeux, 1984; Cuillandre, 1988).

**LOCAL ADDRESSES** Maison du Parc, Centre de Menez-Meur, Hanvec, 29224 Daoulas (Tel: (98) 21 90 69)

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## FRANCE

NAME Vosges du Nord Parc Naturel Régional

IUCN MANAGEMENT CATEGORY V (Protected Landscape)  
IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 2.09.05 (Atlantic)

GEOGRAPHICAL LOCATION The park is situated on the lower Rhine, on the border with Germany, at the base of the Vosges massif in the vicinity of Strasbourg (Moselle and Bas-Rhin departments). It adjoins the 'réserve de chasse' of Petite Pierre. 48°45'-49°11'N, 7°17'-7°55'E

DATE AND HISTORY OF ESTABLISHMENT The site was established as a regional nature park in 1976 by Decree No. 75-983 of 24 October 1975. It encompasses a 'reserve naturelle volontaire' (voluntary natural reserve), 'reserve biologique' (biological reserve) and a 'reserve biologique communale' (communally-owned biological reserve). Vosges du Nord was accepted as a biosphere reserve in 1988.

AREA 120,200ha (a central zone of 200ha, transition zone of 90,000ha and a buffer zone of 30,000ha)

LAND TENURE Mixed public, military and private ownership

ALTITUDE 200-580m (buffer zone average of 250m and a transition zone of 350m)

PHYSICAL FEATURES The park is located in the northern Vosges mountains, an area of undulating relief, incised valleys and lakes. The landscape is divided into three types: the hills of the Piedmont Vosges, the Lorraine plateau and the intervening terrain of Tertiary deposits. The Piedmont Vosges hills are largely composed of fossil-rich limestones fringed by sandstone deposits (Vosges sandstone of the Bunter sandstones with conglomerate and mottled sandstone in the west). There are ancient and recent alluvial deposits in the plains and abundant peat in the Pays de Bitche, an area of windblown sand. Soils are highly calcareous except in the sandstone areas where poor siliceous deposits predominate and range from acid brown types to yellow podzols. Throughout the park there are numerous peat bogs and reed fringed lakes, the best examples being the Etangs of Waldeck and Lieschbach. The Vosges massif is surrounded by the cultivated plains of Alsace.

CLIMATE Temperate with a tendency for semi-continental conditions. The mean temperature of the coldest month is 0.2°C and of the hottest month 17.8°C. The topography creates numerous microclimates, hot and dry on the south and west slopes, colder and more humid on the north and east slopes. Average annual rainfall is approximately 600mm. Deep snows occur in the winter.

VEGETATION The flora of the area is extremely diverse, with over 600 species recorded in habitats ranging from mature forest to acid peat bog, heathland, sand meadows and cliff habitats. More than half of the park consists of high forest represented by mixed oak Quercus sp., beech Fagus sylvatica and Scots pine Pinus sylvestris, as typified by the Forêt de Mouterhouse. The peat bogs contain such characteristic species as Drosera rotundifolia, Sphagnum molle, Lycopodiella inundata, Andromeda polifolia, Rhynchospora alba and R. fusca (Comité Français MAB, 1988). The heathland communities feature a mix of Calluna or Vaccinium heath, coloniser species and peat bog species, including Diphasiastrum



tristachyum, Pulsatilla vernalis, Gentiana pneumonanthe, Juncus capitatus and sphagnum along with naturally regenerating pine. Chasmophytes are typified by Asplenium billotii, Geocalyx graveolens, and Lycopodium selago (Comité Français MAB, 1988). Natural grasslands exist on the calcareous soils at Bastberg, whilst peat bogs are present on sandy soils at higher altitudes (Polunin and Walters, 1985). The semi-natural areas of the park are represented by copses, grazed grassland and hay meadows whilst the conifer plantations contain Abies, Picea and Pinus spp.

**FAUNA** The forest fauna of the northern Vosges includes species such as red squirrel Scuirus vulgaris, red deer Cervus elaphus in the Petite-Pierre sector, roe deer Capreolus capreolus and wild boar Sus scrofa. Of the 130 recorded bird species, 84 nest including peregrine falcon Falco peregrinus, capercaillie Tetra urogallus and cuckoo Cuculus canorus (Comité Français MAB, 1988), whilst on the heathland Lanius excubitor and Lullula arborea can be found. The diverse wetland supports birds such as Podiceps cristatus and Acrocephalus scirpaceus the herpetofauna includes Triturus vulgaire and Natrix natrix (Comité Français MAB, 1988).

**CULTURAL HERITAGE** There are numerous archaeological remains including many ruins from the Gallo-Roman epoch. The traditional glass industry, originally located in the region so as to utilise forest fuels, started at Meisenthal in 1586. Early industrial exploitation aided the rapid development of a rich economy in the area, as is apparent by 40 extant chateaux dating from this period.

**LOCAL HUMAN POPULATION** There are 97 'communes' (parishes) in the park (Moselle and Bas-Rhin departments), creating a relatively dense population of 70 inhabitants per sq.km. (Comité Français MAB, 1988). There is an absence of inhabitants in the central zone. Approximately 10,000 people live in the buffer zone and 85,000 in the transition zone. Almost 2.5 million people inhabit foothills of the massif around Strasbourg, Palatinat and Rhenanie (Comité Français MAB, 1988). The majority of the population is urban following the upheavals caused by the Second World War. The main industries continue to be forestry along with livestock herding and some hunting and fishing. Traditional crafts and small-scale agriculture is threatened as people continue to migrate to jobs in industrial complexes. The tourist industry is of major importance to the area, the current threat being an apparent excess of preservation, commercialisation of the countryside and the transforming of the region into a "reserve-museum" (Desjeux and Desjeux, 1984).

**VISITORS AND VISITOR FACILITIES** Surveys indicate that there up to 100,000 visitors per year (Comité Français MAB, 1988). The main park offices and centres for information are at La Petite Pierre and Wingen sur Moder. There are additional park centres with information on botany, ornithology and forests along with associated exhibitions, courses and literature. Accommodation is available in hotels, inns, guest-houses and campsites. There are hiking trails, up to five horse-riding centres, cycle and canoeing trails and museums specialising in exhibits on the petroleum industry, town-life and natural history. The glass museum, Maison de Verre et du Cristal, at Meisenthal describes the history of the glass trade from its foundation in 1586, as well as the development of the Royal glassworks for Louis XV in the Pays de Bitche. A wildlife park is located at Schwarzbach (Desjeux and Desjeux, 1984; Comité Français MAB, 1988).

**SCIENTIFIC RESEARCH AND FACILITIES** A bird observatory has been constructed on the edge of the Etang de Baerenthal. The Maison des Forêts undertakes ecological

work, including analysis of the peat bog pine woods and its regeneration, with a view to create an integral reserve in the near future. The authorities also undertake long-term surveillance of water ecosystems, survey and prepare vegetation maps and inventories of birds, plant species and invertebrates. Other research themes include those on agriculture, ecological succession, regeneration, fire, silviculture and impact of tourism.

CONSERVATION VALUE Throughout the park there are numerous peat bogs and reed fringed lakes, the best examples being the Etangs of Waldeck and Lieschbach. The flora of the area is extremely diverse, with over 600 species recorded in habitats ranging from mature forest to acid peat bog, heathland, sand meadows and cliff habitats. The heathland communities feature a mix of Calluna or Vaccinium heath which is threatened throughout the whole of Europe. There are numerous archaeological remains including many ruins from the Gallo-Roman epoch.

CONSERVATION MANAGEMENT Le Syndicat Mixte du Parc is the body responsible for management of the park. Local collectives and private organisations have only a secondary involvement. The park authorities manage the park to prevent excessive changes to wildlife, landscape and traditional local industries. Forestry management is a major concern to the Vosges authorities. De Bitche heathland has been under military ownership and management since 1905, where fire clearances have been undertaken every five to ten years to maintain heathland communities. The army controls rights of passage for visitors which can be suspended when military exercises are in progress. The 'Reserve nationale de chasse de la Petite Pierre' is located within the designated combat zone. Peat bogs are artificially regulated by means of dykes as at Waldeck and Lieschbach etangs. The Office National des Forêts undertakes all forestry management and supplies information to visitors. There are proposals to set up a nature reserve covering 8,000ha to protect the more delicate habitats. Future proposals include transfrontier co-operation with Pfälzerland (Palatinat) Nature Park in Germany.

MANAGEMENT CONSTRAINTS Increased mechanisation of existing industries has led to widespread conifer afforestation and associated loss of heathland, native broadleaf woodland and reduction of soil humidity. Farmers continue to experiment with new crops which tend not to be in keeping with the park's aim of retaining the traditional landscape. Further concern is for the loss of the primary habitats on the Haut Vosges ridges which are gradually being replaced by semi-natural meadowland and eroded by increasing pressure from rock climbing.

STAFF Five, of which three are administrators

BUDGET FF 495,000 per year (Comité Français MAB, 1988)

LOCAL ADDRESSES Maison du Parc Naturel Régional des Vosges du Nord, La Petite Pierre, 67290 Wingen sur Moder.

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## FRANCE - Corsica

NAME Vallée du Fango

IUCN MANAGEMENT CATEGORY

IV (Managed Nature Reserve)

IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 2.17.06 (Mediterranean Sclerophyll)

GEOGRAPHICAL LOCATION In north-west Corsica, comprising much of the Fango River catchment on the southern slopes of the central Corsican mountain chain and opening in the north-west onto the Gulf of Galeria. It is located in the Galeria region, within the administrative area of Calvi, 30km south of Calvi and entirely within Corsica Regional Park. The reserve boundary follows the watershed of the Fango River and, on the coastal side, extends to the 50m isobath. 42°23'N, 08°46'E

DATE AND HISTORY OF ESTABLISHMENT The reserve is contained within Corsica Regional Park). Within the core areas are several smaller, separately designated reserves: Ministry of Agriculture and Forests legislation of 7 December 1988 sets out management of the Forêt domaniale du Fango (4318ha). The area of the Fango delta (80ha) is covered by legislation of 5 November 1987 and has been acquired by the Conservatoire de l'Espace Littoral. Also included is the Réserve biologique domaniale intégrale du Malazanca (78ha) The buffer zone includes two communal forests: the Forêt indivise du Filosorma (6410ha) and the Forêt communale de Calenzana (1302ha). A smaller area than at present of 6,410ha, known as the Forêt domaniale du Fango, was accepted in January 1977 as a biosphere reserve and this was extended in February 1990 (MAB France, 1976).

AREA 25,110ha; this includes core areas of 4,398ha, buffer zones of 7,712ha and a transition zone of 13,000ha

LAND TENURE State

ALTITUDE 0-2558m with parts to 50m below sea level in the Gulf of Galeria.

PHYSICAL FEATURES The reserve includes the Fango River catchment area and about 5km of coastline on the Gulf of Galeria. The coastline has several small beaches and rocky headlands. Fango valley is cut into volcanic deposits of rhyolite which filled an older granite depression. The slopes are generally steep and the river itself fast flowing. Much of the area has brown forest soils (MAB France, 1976).

CLIMATE Mediterranean, with hot dry summers and warm winters when most rain falls. Above 1,200m the climate is montane submediterranean. The maximum temperature of the warmest month is 33°C and the minimum temperature of the coldest month is 6°C. Mean annual precipitation is 1000mm at an altitude of 192m (MAB France, 1976).

VEGETATION The natural vegetation of most areas is well preserved scrub dominated by evergreen holm oak Quercus ilex. Other less common trees include maritime pine Pinus pinaster and Corsican pine P. nigra laricio which occur widely only at about 900-1,100m on the slopes of the eastern and, to a lesser extent, the southern peripheries. A few copses and isolated trees grow as high as 1,200-1,300m. Other trees occurring in small numbers include sycamore Acer pseudoplatanus and aspen Populus tremula. The undergrowth consists of brushwood and, in damp areas, alder

Alnus sp. and box Buxus sp. with a ground flora of ferns. Several types of maquis, forming part of the successional series leading to holm oak scrub, occur due to different grazing regimes. Below 300m a species rich, tall maquis dominated by myrtle Myrtus communis with strawberry tree Arbutus unedo, Phillyrea media and P. angustifolia and a number of herbaceous plants predominates. From 300m to about 900m low, submediterranean maquis is dominant and includes several species of Cistus: C. salvifolius, C. incanus and C. monspeliensis. This maquis has suffered more intense grazing pressure which has kept it at the stage of Cissus dominated communities. Threatened or endangered species include Paeonia mascula (very rare in Corsica), Polygonum scoparium, Erodium corsicum, Teucrium flavum, Stachys glutinosas and Genista corsica (MAB France, 1976).

**FAUNA** Mouflon Ovis orientalis occur on the higher mountains where parts of the eastern slopes fall within Asco National Reserve. In the humid winter season there are wild boar Sus scrofa and many deer (Cervidae) throughout the area. Many migrant birds overwinter here. Nesting birds include golden eagle Aquila chrysaetus, lammergeier Gypaetus barbatus and corsican nuthatch Sitta whiteheadi (K). The varied insect fauna includes 13 endemic beetles (Coleoptera) of the 32 species present (MAB France, 1976).

**CULTURAL HERITAGE** The area was managed for a long time by nomadic herdsman from Niolo, on the eastern side of the mountains, who selectively encouraged the evergreen oak forest. Its leaves and acorns were the only food for their livestock on arrival in autumn, as the grass grew only after the spring rains and chestnut trees were scarce. A few families still practise this transhumance system and use areas within the reserve as their winter pastures (MAB France, 1976).

**LOCAL HUMAN POPULATION** The population density of the region is 15 per sq.km. Most people are engaged in agriculture, fishing or hunting with a significant proportion in the coastal area working in the tourist industry. Only seven Forestry Organisation staff live in the core areas. There are about 380 people living in the buffer zones and 780-1,000 inhabitants of the transition zone. The town of Galeria is situated on the coast within the transition zone (MAB France, 1976).

**VISITORS AND VISITOR FACILITIES** There are 8,000-10,000 visitors annually. No special facilities exist apart from general tourist accommodation and other facilities in the transition area. Access to Corsica Regional Park is unrestricted and there are a number of marked footpaths (MAB France, 1976).

**SCIENTIFIC RESEARCH AND FACILITIES** Multidisciplinary ecological studies are being undertaken under contract with the DGRST (Délégation Générale à la Recherche Scientifique et Technologique) including degradation, protection, regeneration of the maquis; socio-economic and demographic problems; studies of the dynamics of oak forest; past and present value and future prospects of the oak forest which is static at present (possibly becoming part of an integrated study of typical Mediterranean forests); comparison with other forests of the Mediterranean periphery and with other oak forests, for example the cork-oak forests of Sardinia and southern Corsica. The PIRIO Laboratory of the Association for Ecological Study of the Maquis (Association pour l'Etude Ecologique du Maquis/APEEM), is situated in Manso; this is a modest country laboratory, where working parties have been meeting for the past three years and courses are held. The PIRIO Meteorological Station has been operating since January 1974. A station for hydrological measurements has also been established on the Fango river. There is

accommodation for 20-25 visiting scientists (MAB France, 1976).

**CONSERVATION VALUE** The reserve comprises a typical catchment in the Corsican mountains. It includes an anthropogenically influenced community of evergreen holm oak Quercus ilex together with two maquis communities typical of Corsica, which are partly influenced by the grazing regime. Traditional transhumance is still practised in parts of the area.

**CONSERVATION MANAGEMENT** The biosphere reserve is located entirely within Corsica Regional Park (150,000ha). Zoning is as follows: the core zone comprises five main areas of hillside with state-owned forest of tall, well-grown trees and also the Fango River delta, a flat area adjacent to the shore of the Gulf of Galeria. The buffer zone comprises several separate areas with, in the west, Tetti and Luccio forests and to the north, degraded oak forest with high and low maquis. To the east the buffer zone includes the sparsely vegetated rocky flanks of the mountain of Cinto and to the south, ridges oak forest giving way to pine groves. The zone of transition "fills in" the rest of the the reserve so that it includes much of the Fango catchment. Grazing by sheep, goats, pigs and cows continues in the buffer and transition zones and helps to maintain the diversity of vegetation types within the maquis. There is some forestry activity in these two zones. Within the transition zone there is some cultivation of lucerne, forage crops and olives and plantations of oak and pines (MAB France, 1976).

**MANAGEMENT CONSTRAINTS** The oak forest is static at present and regeneration needs to be encouraged, especially in degraded areas. The predominance of oak in some areas is not entirely natural as this species was selectively encouraged by man for its acorns, used to feed livestock. There is some uncontrolled habitation along the River Fango and unofficial camping takes place on the beach and in the delta area. Within the core areas gravel extraction occurs and there is poaching in the River Fango, including the use of nets, bleach and electrocution to extract fish. Some fishing and hunting, however, is carried out legally in core areas. In the regional park as a whole, uncontrolled fires can be a problem, consuming 5,000-10,000ha each year particularly in years of drought. They are often started by farmers who want to clear undergrowth to allow fresh grass to grow underneath. During the 19th century the park, like many upland areas, suffered from depopulation and this has led to the old meadows becoming overgrown (Anon., 1986; MAB France, 1976).

**STAFF** Five permanent staff, three from the Organisation Nationale Forestière and two from the nature park, of which one from each organisation is involved in control, resource management and administration. There is also one part time worker and 20 volunteers. In addition, there are ten scientists attached to the APEEM), which has a laboratory at Pirio, who carry out research in the reserve. Three personnel from APEEM and one from the regional park are involved in education and training (MAB France, 1976).

**BUDGET** This forms part of the budget of the Parc Naturel Régional du Corse.

**LOCAL ADDRESSES** Parc Naturel Régional Corse, BP 417, 20184 Ajaccio

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## FEDERAL REPUBLIC OF GERMANY

NAME Biosphärenreservat Mittlere Elbe (Middle Elbe Biosphere Reserve)  
(includes Steckby-Lödderitz National Nature Reserve and Dessau-Wörlitzer Cultural Landscape)

IUCN MANAGEMENT CATEGORY I (Strict Nature Reserve)  
IV (Managed Nature Reserve)  
IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 2.11.05 (Middle European Forest)

GEOGRAPHICAL LOCATION Steckby-Lödderitzer Forest, lies to the west of Dessau and occupies both sides of the middle course of the Elbe River, between Aken and the confluence of the River Saale in Zerbst and Schoenebeck county, Magdeburg District. Dessau-Wörlitzer Cultural Landscape is separate from the nature reserve and is situated east of the town of Dessau and the Mulde River and south of the Elbe River. The village of Wörlitz lies within the cultural landscape. 51°53'N, 11°59'E

DATE AND HISTORY OF ESTABLISHMENT Steckby-Lödderitz was established as a national nature reserve by order of the Ministry of Agriculture and Forestry on 3 March 1961. Accepted as a biosphere reserve in November 1979, the area was extended to include Dessau-Wörlitzer Cultural Landscape and was renamed Middle Elbe Biosphere Reserve in October 1986.

AREA 17,500ha: Steckby-Lödderitzer Forest 5,000ha and Dessau-Wörlitzer Cultural Landscape 12,500ha

LAND TENURE Of the 1979 area of 2,113ha, 90% is owned by the state and 10% by cooperative farms (Anon, 1979).

ALTITUDE 50-75m

PHYSICAL FEATURES The nature reserve is a forested flood plain with meadow land, part of the site being flooded every year by the River Elbe. Numerous stagnant water areas originate from former river sections, such as Lake Goldberg and other oxbow lakes. The sedimentary geology of the area consists of Holocene material (bottom-land loam) overlaying Pleistocene river-bed sands, dunes and deposits of shifting sand. Sediments range from high-nutrient clays, podzolic brown earths to poor sands (Anon, 1979; For further details see summary by Hentschel, Reichhoff, Reuter, and Rossel, 1973).

CLIMATE The mean annual temperature is 8.7°C, mean monthly temperatures range from 0°C in January to 18.5°C in July. The mean annual precipitation is 545mm.

VEGETATION The nature reserve comprises 65% forest land, 9% bogs and lakes, 9% river (Elbe), 9% river bank area and 8% grassland (Hentschel, Reichhoff, Reuter and Rossel, 1973; Seidel, 1983). The area includes extensive Scots pine Pinus sylvestris forest (up to 15m in height) covering dune systems. Hardwood and riverine forests cover 1,500ha with the main species being pedunculate oak Quercus robur, elm Ulmus carpinifolia, U. laevis, hornbeam Carpinus betulus and field maple Acer campestre (Hentschel et.al, 1973; Wirth, 1979). Wild fruit tree species include pear Pyrus achras, apple Malus sylvestris and Pyrus pyraster over a ground flora of Stellaria holostea and Polygonetum multiflorum (Seidel, 1983).

Narrow softwood groves dominated by willow Salix spp. and poplar Populus spp. line the riverside. The flood-plain continues to be occupied by vast grassland areas, periodically flooded by the Elbe River. Representative grassland species include Filipendula hexapetala, Ranunculus polyanthemus, Deschampsia caespitosa, Galium boreale, Silaum silaus, Inula salicina, Peucedanum officinale, Serratula tinctoria, Cnidium dubium, Selinum carvifolia, Lathyrus palustris and Iris sibirica (Hentschel et al., 1973). The species Salvinia natans and Trapa natans have been identified in ox-bow lakes. In total some 50 species are present which are regarded as endangered or rare in the FRG (Wirth, 1979; Seidel, 1983; Hentschel et al., 1973).

**FAUNA** A total of 39 mammal species has been recorded. The reserve is one of the most important breeding sites for some of the last Western European beaver Castor fiber albus, which has been protected since 1913, and consists of 12 colonies. Some 130 bird species breed here and it is an important wintering and passage site for over 100 species. Breeding bird species include lesser spotted eagle Aquila pomarina (in most south-western breeding area), honey buzzard Pernis apivorus, goshawk Accipiter gentilis, black kite Milvus migrans, red kite M. milvus, hoopoe Upupa epops, kingfisher Alcedo atthis, pintail Anas acuta, shoveler A. clypeata and Ortolan bunting Emberiza hortulana (Grimmett and Jones, 1989).

The invertebrate fauna includes Lucanus cervus, Osmoderma eremita (E) and Ephesia fulminea. Pond terrapins Emys orbicularis are also present. Records exist for over 20 species of fish; 46 species of Araneae, 8 of Opiliones, 26 species of Carabidae, 25 species of Coccinellidae, 70 species of Cerambycidae, 180 species of Lepidoptera and 50 species of Mollusca (Anon, 1979; Hentschel et al. 1973; Seidel, 1983).

**CULTURAL HERITAGE** The site has a limited history of forest exploitation and there is evidence of former cultivation within the forest. The little village of Steckby was settled as long ago as 1196. Past management includes the diking of the Lödderitz meadow in 1860 (Seidel, 1979).

**LOCAL HUMAN POPULATION** Human activities include agriculture and forestry (Grimmett and Jones, 1989). There are no settlements in Steckby Nature Reserve. The village of Wörlitz lies within the cultural landscape. The Middle Elbe River flood plain and domestic livestock pasture is contained between the agricultural ploughland of Zerbst and the foreland of the forested Magdeburger Boerde.

**VISITORS AND VISITOR FACILITIES** The area is traditionally much visited by foreign tourists. Facilities include the Bastei region nature trail. Excellent rock-climbing opportunities are available at Rathener Felsenkessel (Wirth, 1979).

**SCIENTIFIC RESEARCH AND FACILITIES** A number of scientific projects have been running for a substantial period of time. Research intended to establish inventories of animal populations has been continuing since 1920, with particular attention to beavers and bird ringing (Hentschel et al., 1973). Experiments in pest control by attracting birds to nesting boxes has been carried out since 1925, supported by the Association for the Protection of Birds. Other ongoing studies include research into the structure and dynamics of lowland forests, soil and vegetation mapping. There are five permanent plots for monitoring changes in structure and dynamics of hardwood forest. Potential activities include protection and management of habitats, waterfowl counts, and long-term studies on the structure and dynamics of forest and grassland ecosystems. Field studies are conducted by the Biological Research Station at Steckby, and by the Institute of Landscape Research and Nature Conservation of the Academy of Agricultural



Sciences. Between 1973 and 1981 the station has reared over 190 great bustards Otis tarda from eggs collected from disturbed nests (Seidel, 1983).

CONSERVATION VALUE The reserve is of note for its rich and diverse forest and river floodplain ecosystems, most noted for its European beavers and for invaluable data resulting from continued scientific research over the last 70 years. Steckby-Lödderitzer Forst is widely regarded as one of the most valuable residual flood-plain forests of Central Europe (Schlosser, 1985). The forest is also important for in situ conservation of wild fruit crop genetic resources (Schlosser, 1985).

CONSERVATION MANAGEMENT A management plan exists for the development, management and cultivation of the area. The buffer zone is managed according to guidelines established by Magdeburg District Council. The strict nature reserve covers 3,500ha with a core zone of 400ha (after the extension of the site on 10 December 1981) and 100ha of a 'regeneration zone'. The biosphere reserve extension approved in October 1986 confirmed a larger total core area, a buffer zone area and created a 'cultural landscape' area. Steckby-Lödderitzer Forst and Zerbster Ackerland are listed as important bird Areas, wetlands of national importance and as bustard protection areas (Grimmett and Jones, 1989).

MANAGEMENT CONSTRAINTS Most forest land is unaltered but Ulmus carpinifolia is declining due to insect viruses. Hunting and agriculture are practised in accordance with the needs of nature conservation. There are some shipping activities on the River Elbe, and the river is polluted.

STAFF Includes three research workers and two technical staff of the Institute for Landscape Research and Nature Conservation, Halle. Two supervisors are employed by the District Council (Seidel, 1983).

BUDGET No information

LOCAL ADDRESSES Rat des Bezirkes Magdeburg, Abteilung Forstwirtschaft - Naturschutz, Olvenstedter Strasse, 4, PSF1, Magdeburg 3010

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## DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA

NAME Mount Paekdu Nature Reserve and Biosphere Reserve

MANAGEMENT CATEGORY IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 2.14.05 (Manchu-Japanese Mixed Forest)

GEOGRAPHICAL LOCATION In the northern part of Sanjiyun County, 72km north of Hyesan. Its northern edge is the border with China, which is formed by the Amnok River to the west, the Paekdu mountain range in the centre and the Tuman River to the east. The other side of the border is the Chinese Biosphere Reserve of Changbaishan. 41°56'N, 128°10'E

DATE AND HISTORY OF ESTABLISHMENT The Paekdu Nature Protection Area of 14,000ha was established in 1976 and is protected by Resolution of the Ministerial Council No. 55 of 2 October 1976. The crater lake of Chon-ji has been designated a national monument and is protected as a strict nature reserve within the Paekdu Nature Protection Area, which also includes a forest reserve, an experimental and scientific reserve and an area of protected landscape. The reserve was accepted as a biosphere reserve in 1989 (MAB Korea, 1989).

AREA 60,000ha, including a core area of 24,000ha and a buffer zone of 36,000ha. There is also a transition zone of 72,000ha (MAB Korea, 1989).

LAND TENURE State

ALTITUDE 1,400-2,750m

PHYSICAL FEATURES The reserve lies on the southern half of a volcano. Its crater contains a lake and the volcano's flanks slope uniformly towards the south. The lower slopes are gentle but above 2,350m they can be as steep as 35° to 80° and of bare rock. The first eruptions of basic lavas occurred about 1.8 million years ago but were covered during the Quaternary period with acid pumice ash which is 15m deep near the top of the mountain, decreasing to 7m deep near the southern edge of the reserve and to 2-3m near Mupo in the east. Eruptions occurred in 1597, 1668 and 1702. This ash is highly erodible and is dissected in places by fluvial erosion and locally shaped into ridges by wind action. There is generally much wind erosion and solifluction. The crater lake at 2,250m is 14.4km in circumference and has a maximum depth of 384m. The crater itself has cliff-like walls 500m high. Small lakes occur in the ash fields at the lowest point between Mt Paekdu and the subsidiary vent of Bukpotee. The soils are mainly alpine brown soils with some podsolisation (MAB Korea, 1989).

CLIMATE Alpine and subalpine climate; there is no permanent snow but even in summer a few small snowfields remain. Mean annual precipitation is 921mm (30-year average) at an altitude of 1,450m; 1200mm (10 year average) at an altitude of 2,350m. Mean annual temperature is 0.4°C at 1,450m and -2°C at 2350m (MAB Korea, 1989).

VEGETATION Above 1,900m there is alpine tundra-like vegetation composed of an open sward of grasses, sedges, Dryas, Rhododendron spp. and herbs with arctic affinities. Between 1,500m and 1,900m communities representing various stages of recolonisation by forest of the pumice ash occur and the forest is still expanding upwards. At all altitudes the dominant species is larch Larix olgensis but the

more mature forest contains a mixture of larch with spruce Picea jezoensis and fir Abies nephrolepis. Many more communities can be distinguished by their ground flora (Rhododendron, Calamagrostis, Potentilla). There is some tall, mixed-age mature forest in the south which is presumed to be climax forest. The buffer zone is mostly logged and managed larch forest; much of the area was logged by the Japanese in the 1920s and 1930s and is secondary. About 580 species of higher plants have been recorded including some endemic species (MAB Korea, 1989).

**FAUNA** There are 50 species of mammals and 138 of birds recorded from the reserve which are listed in the biosphere reserve nomination. Important mammals which are resident include grey wolf Canis lupus chanco (V), brown bear Ursus arctos lasiotus, leopard Panthera pardus orientalis (T), sika Cervus nippon hortulorum, musk deer Moschus moschiferus; birds include Chinese merganser Merquus squamatus, black grouse Tetrao tetrix, black woodpecker Dryocopus martius; fish include Saverinus malma curilus and the butterfly Parnassus nomion occurs here (MAB Korea, 1989).

**CULTURAL HERITAGE** Sanjiyun used to be used as a centre for teaching the history of the revolution to Koreans and others and this area is full of sites which played some part in the struggle for independence from Japan. There is a memorial to the Revolutionary March near Sanjiyun (MAB Korea, 1989).

**LOCAL HUMAN POPULATION** There is some human settlement with about 100 people living permanently in the core area, 6,900 within the buffer zone and 30,000 around the reserve in the transition area. It has not yet been decided whether to include the settlement of Sanjiyun, a small county town situated at the lowest point in the valley between Mt Paekdu and the neighbouring vent of Bukpotee, in the biosphere reserve (MAB Korea, 1989).

**VISITORS AND VISITOR FACILITIES** About 23,000 visitors come to the reserve each year. Access is good and there is a tourist hotel by Lake Sanjiyun plus ample hostel accommodation (MAB Korea, 1989).

**SCIENTIFIC RESEARCH AND FACILITIES** The larger flora and fauna have been enumerated, vegetation mapped and forest types classified. Forest dynamics are beginning to be investigated and these studies will be intensified with the establishment of permanent vegetation plots, starting with studies of productivity and nutrient circulation in forest ecosystems, microclimatology, soil/vegetation inter-relationships, microbiology and animal populations. Primary geological and geographical surveys have been carried out and the hydrology of Lake Chon has been surveyed. There is a meteorological station at 2,350m. The main research station involved in the reserve is at Pyongyang, several hundred miles away, with a subsidiary station at Hyesan, three hours' drive from the reserve. A field station is planned at Sanjiyun, and there is abundant accommodation here, in the form of hostels for teaching students and workers about the revolution, which could be used by scientists. Ten experimental plots, totalling 5ha, already exist, three above and seven below the forest limit. There is a research staff of six, four of which have university training (MAB Korea, 1989).

**CONSERVATION VALUE** The reserve includes the relatively undisturbed southern slopes of a dormant volcano, including a crater lake with examples of recolonisation following relatively recent eruptions. It includes relatively high areas with alpine tundra-like vegetation and, between 1,500m and 1,900m, communities representing various stages of recolonisation by forest of the pumice ash. The forest is still expanding upwards and at all altitudes the dominant species is larch Larix olgensis. Resident mammal species include grey wolf Canis

lupus chanco (V), brown bear Ursus arctos lasiotus, leopard Panthera pardus orientalis (T), sika Cervus nippon hortulorum and musk deer Moschus moschiferus. The area also has a number of sites of cultural interest, dating from the Revolution.

CONSERVATION MANAGEMENT There are two separate management plans, one for the area already designated as a strict nature reserve (the upper part of the mountain) and one for the part of the forest which is under economic management, but these will soon be combined in a plan for the whole reserve. A large core area will be established above about 1,600m and will include the crater and lake. Core area status will also be given to a number of other smaller areas containing examples of undisturbed, natural forest types. A corridor for tourism and recreation will pass through the core zone to the top of the mountain and will include the meteorological station. In the buffer zone, most of the forest will be managed for timber production, but 500ha is being set aside for the experimental cultivation of Vaccinium uliginosum. A number of Revolutionary Sites (significant for their part in the struggle for independence from Japan) are to be zoned separately (MAB Korea, 1989).

MANAGEMENT CONSTRAINTS There is intensive use by tourists of the corridor to the mountain summit; some damage has been caused here in the tundra zone as the ash is unconsolidated and thousands of pilgrims visit each year, but otherwise the core area has been little modified by man. In the buffer zone timber exploitation occurs, the main species being larch, fir, spruce and birch. There are some minor roads and an experimental farm for growing Vaccinium uliginosum. A few crops are cultivated, including wheat, barley, potatoes and flax. Some collection of natural products such as Pteridium also takes place (MAB Korea, 1989).

STAFF Total of 30, including 23 involved in administration, control and resource management, one for education and training and six in research (MAB Korea, 1989).

BUDGET 100,000 Won per year

LOCAL ADMINISTRATION Secretary-General, MAB National Committee, c/o Academy of Sciences, Sosong District, Pyongyang

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## MADAGASCAR

NAME Réserve de la biosphère de Mananara Nord

IUCN MANAGEMENT CATEGORY IV (Managed Nature Reserve)  
IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 3.03.01 (Malagasy Rain Forest)

GEOGRAPHICAL LOCATION Situated on the east coast of Madagascar, 225km from Toamasina, in the sub-prefecture of Mananara Nord. The reserve is bounded to the north by the mouth of the River Mananara, then by the Mananara and Sandrakatsy rivers to the source of the latter. From there, the boundary runs south-west to Fotsialanana and thence to the mouth of the River Anove. An area extending approximately 5km offshore between the mouths of the two rivers is also included. The reserve includes a terrestrial national park (in two blocks) and a marine national park centre on Nosy Atafana. 16°14'-16°32'S, 49°38'-49°50'E

DATE AND HISTORY OF ESTABLISHMENT Three areas within the reserve were declared as classified forests on 19 March 1965 (Decree 893 MFR/FOR), Ivontaka Nord, Ivontaka Sud and Verezanantsoro. A law establishing the 'Réserve de la biosphère à Mananara-Nord' was passed on 25 July 1989 (Decree No. 89-216). This defines three parts to the reserve; a terrestrial national park, a marine national park and a multiple development zone. The terrestrial park, which covers 23,000ha, comprises the three classified forests previously declared. A biosphere reserve nomination, submitted by the Direction des Eaux et Forêts, was accepted by the MAB Bureau in 1990.

AREA 140,000ha. The core zone covers 24,000ha comprising a 23,000ha terrestrial national park (in three blocks), and a 1,000ha marine national park. The biosphere reserve nomination identifies a buffer zone of 15,000ha and a transition zone of 101,000ha, although these are not identified as such in the decree establishing the site.

LAND TENURE Forested regions belong largely to the government, and cultivated areas are mostly privately owned.

ALTITUDE Ranges between 0m and 570m, to -50m offshore

PHYSICAL FEATURES The reserve is coastal and comprises crystalline hills (Antongil granite and Mananara magnetite) rising in general to around 500m. Soils are weakly ferralitic to ferralitic with a narrow sandycoastal strip between Anove and Antanambe. The coast is a succession of beaches, but north of Antanambe they are isolated and the rugged coastline faces partially submerged reefs which break the surface as far as 200m out to sea and sometimes beyond. Reefs are also found around the island of Nosy Atafana. The granite is deeply cut by valleys formed by clear, fast-flowing rivers meandering to the littoral plain or alluvial valleys before reaching the coast. The rivers heading east are shallow, forming numerous sandbanks and islets.

CLIMATE Humid tropical with annual precipitation varying from 2800mm to 3200mm over 180 days. There is no dry season but October is the driest month with 101mm of precipitation. Monthly temperatures vary from 19°C-26°C, minima and maxima from 18-23°C and 24-30°C, respectively. Temperatures are warmer from November to March.

**VEGETATION** The natural vegetation consists primarily of tropical humid forest, within which at least two communities can be distinguished associated with differences in soil type. On the sandy coastal plain, littoral vegetation comprises Terminalia catappa, Calophyllum sp., Canarium sp. and Heritiera sp. Mangrove formations are dominated by Rhizophora mucronata and Avicennia marina. On lateritic soils typical genera are Weinmania, Tambourissa, Diospyros, Ravensara, Oncostemon, Dysoxylum and Chrysalydodermis. Best represented families are Rubiaceae, Ebenaceae, Monimiaceae, Apocynaceae, Burseraceae, Euphorbiaceae, Orchidaceae, Arecaceae and the endemic Sarcocaulaceae. Canopy height is 30-35m with emergents reaching 40m. Aponogeton and Hydrostachys spp. are abundant along river courses. Outside the classified forests, much of the biosphere reserve has been deforested by tavy (shifting cultivation).

**FAUNA** The reserve has not been well studied, but appears to be rich in rain forest and coral reef communities. Mammals include broad-striped mongoose Galidictis fasciata and salango Salanoia concolor, diadem sifaka Propithecus diadema diadema, ruffed lemur Varecia variegata, indri Indri indri, aye-aye Daubentonia madagascariensis, the rare hairy-eared dwarf lemur Allocebus trichotis, and broad-nosed gentle lemur Haplorhina simus in the south. Reptiles include Crocodylus niloticus, Ithycyphus perineti and Chamaeleo cucullatus. The area is a probable refuge for dugong Dugong dugong. Sixty species of birds were recorded in 1989, including scaley ground roller Brachypteracias squamigera, short-legged ground roller B. leptosomus and helmet bird Euryceros prevostii. It is one of the few rain forest regions where white-browed owl Ninox superciliosus occurs. A preliminary species list is given in Nicoll and Langrand (1989).

**CULTURAL HERITAGE** No information, although Direction des Eaux et Forêts (1989) indicates that anthropological research is ongoing within the area.

**LOCAL HUMAN POPULATION** Approximately 40,000 people live within the reserve, supported by subsistence agriculture of rice, taro, bananas, mangos and lychees, as well as traditional pasturing of zebus, pigs, chickens, geese and turkeys. Cash crops such as cloves, vanilla, coffee and pepper are also grown. The forests supply honey, medicinal and edible plants and there is fishing. Several dozen families actually live within the core zone of the reserve, and several hundred in the buffer zone.

**VISITORS AND VISITOR FACILITIES** The area is accessible by road from both Toamasina and Maroantsetra, and Mananara is served by flights three times a week. There are regular boat services from Maroantsetra, Ile Sainte Marie and Toamasina. There are hotels and shops at Mananara. The number of visitors to the reserve is fairly low.

**SCIENTIFIC RESEARCH AND FACILITIES** According to Nicoll and Langrand (1989) there are no facilities within the area and no research has been undertaken, although a study of aye-aye was proposed by the Muséum National d'Histoire Naturelle (Paris) in 1987-1988. The biosphere reserve nomination (Direction des Eaux et Forêts, 1989) indicates that there are some 20-30 nationals carrying out research on the area, and 8-10 foreign scientists, with a fairly wide range of research activities both underway and planned. The Direction des Eaux et Forêts (1989) also lists a range of research facilities, including laboratories and lodging for scientists.

**CONSERVATION VALUE** There are few protected areas in the low altitude rain forest of Madagascar, which makes the 23,000ha terrestrial national park of particular interest. It is currently the largest legally protected block of low altitude

rain forest in the country. Two carnivores, broad-striped mongoose Galidictis fasciata and salano Salanoia concolor are only protected within this reserve, and the rare Allocebus trichotis has recently been seen here. The reserve is also located in an area of economic importance for the production of cloves, coffee and vanilla.

**CONSERVATION MANAGEMENT** The decree instituting the biosphere reserve defines such areas ecologically representative zones which combine conservation with ecological research, monitoring, education, training and traditional use of the land. The terrestrial national park is established according to the dispositions of the African Convention (Algiers, 1968), while within the marine park all collection, fishing and introduction is prohibited. Elsewhere within the biosphere reserve, economic and industrial development is only permissible if it is in line with the management plan.

There is as yet no management plan. It is intended that agricultural land will be improved, in particular through small-scale irrigation to boost rice production. A range of management recommendations has been made by Olivier and Langrand (1989), as part of a project carried out by WWF and the Ministère de la Production Animale et des Eaux et Forêts.

**MANAGEMENT CONSTRAINTS** There is illegal timber exploitation in the classified forest areas, in particular throughout the Ivontaka Nord and Ivontaka Sud blocks, and to a lesser extent in the northern sector of Verezanantsoro (Nicoll and Langrand, 1989). Principal species extracted are Diospyros spp., Dalbergia spp. and Ravensara spp. Villagers living near the classified forests cut trees in order to grow dry rice, obtain construction materials and firewood. Poaching occurs, principally of lemurs, but also involving dugong. A road has been proposed by cultivators linking Sandrakatsy and Antanambe, passing through the Verzanantsoro block. Tracks abandoned 20 years ago by the Société des Moulins de Dakar have been reopened by forest exploiters and facilitate the extension of slash and burn agriculture.

**STAFF** According to the Direction des Eaux et Forêts (1989), the total staff is 12, with four of these involved in administration and management.

**BUDGET** 1,280 million Malagasy Francs, with some international support (Direction des Eaux et Forêts, 1989)

**LOCAL ADDRESSES** Direction nationale du Project, Mananara Nord

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## MEXICO

**NAME** Reserva de la Biosfera "El Cielo"

**IUCN MANAGEMENT CATEGORY** VIII (Multiple Use Management Area)  
IX (Biosphere Reserve)

**BIOGEOGRAPHICAL PROVINCE** 1.10.07 (Tamaulipan)  
1.21.12 (Madrean-Cordilleran)

**GEOGRAPHICAL LOCATION** Lies in the south-east of Tamaulipas State, 120m from the Gulf of Mexico. Settlements close to the area are: Llera to the east, Jaumave to the west and Ocampo to the south. The Rio Guayalejo marks the northern limit of the reserve. The boundary passes through four municipal districts: Gomez Farias, Llera, Juamava and Ocampo. The most important access roads are the Ciudad Mante-Ciudad Victoria Highway to the west and the Jaumave-Ciudad Victoria Highway to the north. 22°55'-23°25'N, 99°05'-99°26'W

**DATE AND HISTORY OF ESTABLISHMENT** Declared a biosphere reserve by the Tamaulipan State Authority on 13 July 1985 in the Official Bulletin No. 56. The Government approved the programme on 28 December 1985 in the Official Bulletin No. 104. Accepted by Unesco as a biosphere reserve in October 1986.

**AREA** Total area of 144,530ha; core are 36,538ha (core area 1 with 28,694ha and core area 2 with 7,844ha); buffer zone of 91,998ha. Other areas occupied by the reserve are as follows: Llera 17,331ha; Jaumave 81,451ha; Ocampo 24,005ha and Gomez Farias 21,744ha.

**LAND TENURE** State and local community. A high proportion of land is under common ownership, the "ejidal" system covering 30,958ha.

**ALTITUDE** 100-2,300m

**PHYSICAL FEATURES** Terrain rises from the coast in the east to the Sierra Madre Oriental Mountain Range further to the west, which follows a north-south axis, and the Sierra de Cucharas. The mountains consist of rocks of the Cretaceous period that have been eroded to form abrupt relief features and small valleys. Fluvial systems in the area drain into the Rio Guayalejo. The eastern slopes of the area form the sources of the Sabinas and Frio rivers.

**CLIMATE** Mean annual rainfall is 1350mm and mean annual temperature is 23°C at an altitude of 350m.

**VEGETATION** Five types of vegetation have been distinguished. On the slopes facing the Gulf, between 200m and 800m, is sub-deciduous tropical forest, representative species including Bursera simaruba, Brossimum alicastrum and Enterolobiu cyclocarpum. Between 800m and 1,400m the vegetation consists of mountain mesophyll forest where holarctic species coexist with tropical species. Between 1,400m and 2,300m the vegetation is pine-oak forest, with Pinus patula, Pinus pseudostrobus and Quercus laurina dominant. On the western slopes there is sub-mountain chaparral and matorral vegetation.

**FAUNA** Fauna from both the nearctic and neotropical provinces are represented, species include jaguar Panthera onca (V), ocelot Felis pardalis (V), wild cat Lynx rufus, white-tailed deer Odocoileus virginianus leucurus and temargate Mazama

americana. Some 255 species of resident birds, 175 of migratory birds, 21 of amphibians, 60 of reptiles and 40 species of bat have been reported.

CULTURAL HERITAGE No information

LOCAL HUMAN POPULATION Within the reserve there is a municipal township and 21 production units (ejidos), with a total population estimated at 2,500. The Government and the Autonomous University of Tamaulipas (Universidad Autonoma de Tamaulipas) organise working group meetings for the local population to express their views. The local population is being encouraged to participate in rural development programmes such as apiculture, aquaculture and horticulture.

VISITORS AND VISITOR FACILITIES No information

SCIENTIFIC RESEARCH AND FACILITIES Scientific research over the last 40 years has concentrated on increasing knowledge of the geology and vegetation in this mountain environment. A rural survey is at present being carried out to determine exact demarcations for each type of land tenure. Ongoing projects approved by the State Government are coordinated by the Autonomous University of Tamaulipas. To implement the present programme, two ecological stations and a research and monitoring centre will be created. Present facilities include a research station, field station, experimental plots and accommodation for scientists. A monitoring programme is being conducted by the Secretariat for Urban Development and Ecology (SEDUE).

CONSERVATION MANAGEMENT The area contains extensive portions of forest that show little sign of alteration by man. There are two core areas, the largest one in the north-east, the smaller in the south. Core Area 1 of 28,694ha includes mountainous mesophyll forests and pine-oak forests, while Core Area 2 of 7,844ha includes sub-deciduous tropical forests. In these areas no public or private work is permitted, hunting is forbidden and other activities restricted. The remaining 91,998ha is a buffer zone in which forestry and other activities are managed. There is a management plan. A team of six guards and one coordinator is responsible for ascertaining the level of exploitation and illegal extraction of resources. The University of Tamaulipas aims to carry out an interpretative programme with the local population, emphasis being given to ecological awareness and basic agricultural education as a part of development. A meeting to analyse alternative use of the forest in the reserve was held in 1989.

MANAGEMENT CONSTRAINTS Damaging activities that the SEDUE team has been created to monitor include illegal extraction of wild species, poaching, clandestine wood extraction and squatter settlements.

STAFF Fifty nine. Twenty one are administrative staff, twelve of whom are university trained. Thirty eight are research staff, thirty two of whom are university trained.

BUDGET No information

LOCAL ADDRESSES Dra en C Sagrario Lavin Flores, Universidad Autonoma de Tamaulipas, Matamoros y Calle 8 Apdo 186, 87000 Ciudad Victoria, Tamaulipas

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## MEXICO

NAME Reserva de la Biosfera de Sian Ka'an

IUCN MANAGEMENT CATEGORY II (National Park)  
IX (Biosphere Reserve)  
X (World Heritage)

BIOGEOGRAPHICAL PROVINCE 8.01.01 (Campechean) and partly 8.15.04 (Yucatecan)

GEOGRAPHICAL LOCATION Situated on the Caribbean coast in the south-east of the country, on the eastern side of the Yucatan Peninsula in the State of Quintana Roo (municipalities of Cozumel and Felipe Carrillo Puerto). Where possible, boundaries were defined to coincide with natural features. To the east the reserve is bounded by the Caribbean Sea and the barrier reef to a depth of 50m, to the south-east by the junction between the marshes and the semi-evergreen forests, to the south by the boundary of the municipal districts of Felipe Carrillo Puerto and Othon P Blanco (which coincides with the junction of the catchment basins of Chetumal and Espiritu Santo bays). Political boundaries are only found to the north and north-east, defined by the border of the farming cooperatives of Pino Suarez and Chunyaxché. 19°05'-20°06'N, 87°30'-87°58'W

DATE AND HISTORY OF ESTABLISHMENT Sian Ka'an was declared a biosphere reserve on 20 January 1986 by the Federal Government, and was accepted as a biosphere reserve by the MAB International Coordinating Council in late 1986. It was inscribed on the World Heritage List in 1987.

AREA 528,000ha, of which some 120,000ha are marine. The core zone of the MAB reserve covers 279,704ha.

LAND TENURE The Federal Government owns 99.8%, the remainder being privately owned.

ALTITUDE 0m-10m

PHYSICAL FEATURES Lopez Ornat (1983) gives a detailed account of the physical features of the Yucatan Peninsula and of the reserve itself. Much of the reserve lies in a zone of recent origin (Pleistocene), and appears to still be in a transition stage. The reserve lies on a partially emerged coastal limestone plain, and includes coral reefs (part of the extensive barrier reef system which has formed along the eastern coastline Middle America), the marine zone between reef and shore (including two large bays), coastal dunes, mangroves, marshes, and inundated and upland forests. A large series of sink holes (cenotes) exists in the area; these are characteristic features of the Yucatan and Florida peninsulas (Consejo Duenas *et al.*, 1987). The hydrological cycle is complex, and the water table is permanently close to the surface (never deeper than 8m). As a result, up to 75% of the terrestrial part of the reserve is flooded each year by the end of the rainy season (the dry season figure is 20%). There is little surface running water within the reserve, and water usually filters fairly rapidly through the shallow rendzina and 'saskab' (granular whitish and brittle limestone) soils and the limestone rock to subterranean channels. Due to their hardness, the waters in the reserve are generally very clear. A geological fault crosses the reserve from the south-west to the north-east influencing its topography and hydrology. In general, soils are not suitable for agriculture (Consejo Duenas *et al.*, 1987).

**CLIMATE** The climate, which is tropical with summer rains and occasional cyclones, is described by Lopez Ornat (1983). There are no meteorological stations within the reserve, but data are available from a number of stations within a 25km radius. In Palmas, to the north of the reserve, mean monthly temperature lies between 22°C (January/February) and 27.8°C (May). Mean annual temperature was 25.4°C during the 1961-1980 period, and minimum and maximum temperatures were 4.5°C and 40.5°C respectively. Mean annual rainfall is around 1128mm (derived from 15 years measurement), and three-quarters of this falls between May and October, with September being the wettest month (mean 208.1mm) and March the driest (mean 29.4mm). Easterly winds blow almost continuously from May to November, while northerly winds, which may reach 100km/h, blow during the dry season. Mean relative humidity is around 80%. Cyclones may occur between June and October, with a peak occurrences in September. Strong marine tornados or 'mangueras' can also occur between May and October, although their action is very limited and brief.

**VEGETATION** Olmsted *et al.* (1983) describe the following types of vegetation in the reserve: medium altitude semi-evergreen forest; medium and low altitude semi-deciduous forest; low altitude flood forest; tasital (or palm savanna) formation; freshwater and saltwater marshes; petenes (or hammocks); dwarfed mangroves; fringing mangroves; and dunes and keys. A total of 4,000 plant species has been recorded (Consejo Duenas *et al.*, 1987). More details of the vegetation with list of species are given in Olmsted *et al.* (1983), Cabrera *et al.* (1983) who report 520 species of vascular plants for the reserve, and Espejel Carvajal (1983).

The medium altitude semi-evergreen forest covering about 108,500ha represents the climax in the non-flooded areas, although mature vegetation is scarce in the accesible parts of the reserve due to disturbance. Olmsted *et al.* (1983) list 120 species of trees and shrubs, amongst which common large tree species include *Manilkara zapota*, *Metopium brownei*, *Bursera simaruba* and *Lysiloma latisiliquum*, and in some areas *Brosium alicastrum* and *Mastichodendron foetidissimum*. *Thrinax radiata*, a palm 8-10m high, is the most abundant plant, and *Nectandra coriacea*, *N. salicifolia*, *Byrsonima bucidafolia*, *Coccoloba* sp. and *Caesalpinia gaumeri* are also common. The number of epiphytes and climbers depends on the level of disturbance and age of the forest, and ground cover is also very variable. The area covered by medium and low semi-deciduous forest is less than that of the evergreen forest (11,700ha). Olmsted *et al.* (1983) list 100 species of tree and shrub, the main species being *Bursera simaruba*, *Lysiloma latisiliquum*, *Manilkara zapota*, *Metopium brownei*, *Piscida piscipula* and *Psidium sartorianum*. The abundance of *Beaucarnea ameliae* and the palm *Pseudophoenix sargentii* are characteristic of these forests. The height of the dominant species in the low/medium forest reaches 14m but is more usually 10-12m, while in the low forest tree heights range 2-9m. Flood forest is subdivided into low forest with closed canopy, and open canopy tree communities, the latter being found in the lower, wetter areas. Dominant species in the tree community are *Haematoxylon campechianum*, *Bucida spinosa* and *Dalbergia glabra*, with other common species including *Byrsonima bucidafolia*, *Bravaisia tubiflora*, *Metopium brownei*, *Cameraria latifolia*, *Erythroxylon areolatum* and *Malpighia lundellii*. *Acoelorrhaphe wrightii* and *Crescentia cujete* are frequently found in more flooded areas. There are also many epiphytes and 'showy' herbaceous species. In the flooded low forest, dominant species are *Metopium brownei*, *Manilkara zapota*, *Bucida buceras* and *Lysiloma latisiliquum*, and prominent trees reach up to 12m. Aggregations of *Tasite acoelorrhaphe wrightii* (flooded palm) are found scattered in slightly higher areas which are frequently flooded, in the grass marshlands and forming a fringe in the posterior part of the marshlands, or amongst the dry and flooded forests (Olmsted *et al.* 1983). *Tasite* can form monospecific 'islands' on patches

of dark soil, but where it is common it often associates with Acrostichum danaeafolium, Bucida spinosa, Cladium jamaicense, Conocarpus erectus, Dalbergia glabra, Chrysobalanus icaco and Thrinax radiata.

Olmsted et al. (1983) describe the grass communities which cover large areas to the south and north of the reserve amongst the mangroves and inland forests (though not in areas of higher salinity). This vegetation type occurs as a mosaic with three intermingled associations dominated by Cladium jamaicense, Schoenus nigricans, and Eleocharis cellulosa respectively. Other species found with these communities are Cassytha filiformis, Ipomoea sagittata, Pluchea purpurascens, Crinum americanum, Fuirena breviseta, Dichromena ciliata, Eleocharis caribea, Bletia purpurea, Agalinis sp. and Dichanthelium dichotomum. Petenes or hammocks, raised wooded islands round or ovoid in shape, emerge from the flooded marshes covering areas ranging from several tens of metres in diameter to more than 1km. Larger petenes may have a central waterbody. These islands are vegetated by aggregations of Cladium, Phragmites australis, Conocarpus erectus, Bucida spp., Crescentia and Haemotoxylon, and the trees Metopium, Ficus and Plumeria, and palms Thrinax and Sabal up to 12-15m high are also found. There are extensive areas covered by scattered dwarf mangroves to the east of the freshwater marshes. Plants cover 35-40% of the substrate, with Rhizophora mangle (which may reach up to 2m high) occupying much of this. Soil salinity is high, and during the dry season the ground completely dries, while during the flooding season the thin layer of water can reach temperatures as high as 50°C. In the fringing mangroves, the main arboreal components in order of resistance to salinity are Rhizophora mangle, Avicennia germinans and Laguncularia racemosa and trees have a mean height of about 10m. In drier parts, Conocarpus erectus, Manilkara zapota and Thrinax radiata are also present. Non-tree species are the mangrove fern Acrostichum danaeafolium and the climber Rhabdadenia biflora.

Coastal dunes are found on the part of the littoral facing the open sea and total 64km from the northern limit of the reserve to Punta Allen and from Punta Hualastoc to Punta Tupac. Due to its closeness to the Caribbean islands there is an affinity with their flora exceptional in Mexico (Rzedowsky, 1978; Espejel, 1983). Some endemics are Cordia sebestana, Metopium brownei, Acoelorrhaphe wrightii, Suriana maritima, Turinar radiata and Tournefortia quaphalodes. Also present are the exotic species Cocos nucifera, Casuarina equisetifolia and Colubrina asiatica. The introduction and cultivation of coconuts have substituted the natural vegetation on the coastal dunes by about 60% (Espejel Carvajal, 1983). On keys, R. mangle is the dominant species and the only one in the smaller keys. Thalassia is found with it on larger keys. A number of drier areas have been disturbed. Selective felling has affected the mahogany Swietenia macrophylla, red cedar Cedrela odorata, white cedar Simarouba glauca, Cordia dodecandra, Guaicum sanctum, Metopium brownei and Thrinax radiata. Man-induced fires for agriculture have affected at least 14,000ha of which only 2,000 are in use. These areas are mainly found on both sides of the main road.

**FAUNA** Garcia Salazar (1983) gives a preliminary checklist of the various vertebrate species found in the reserve, and it is possible that all vertebrate species characteristic of the Yucatan region occur. Twenty-eight species of mammal have been recorded including five species of cat, jaguar Panthera onca (V), puma Felis concolor, ocelot F. pardalis (V), margay (or tigrillo) F. wiedii (V) and jaguarundi F. yagouaroundi (I), Central American tapir Tapirus bardii (V), Caribbean manatee Trichechus manatus (V), spider monkey Ateles geoffroyi (V), howler monkey Alouatta villosa (I), kinkajou Potos flavus, white-tailed deer Odocoileus virginianus, red brocket Mazama americana, peccaries Tayassu pecari and T. tajacu, paca Agouti paca, tayra Eira barbara and collared anteater Tamandua

tetradactyla (Consejo Duenas et al. 1987). One hundred and nineteen species of bird are listed by Garcia Salazar (1983). However, it is estimated that the number of species occurring is nearer 350, with some two-thirds breeding inside the reserve. Due to the great diversity of aquatic habitats, marine and wading birds are well represented, and there are at least 16 species of raptor. Amongst these, frigate bird Fregata magnificens, comorants Phalacrocorax spp., roseate spoonbill Ajaia ajaja, greater flamingo Phoenicopterus ruber and jabiru Jabiru mycteria are found (Consejo Duenas et al., 1988). Forty-two species of amphibian and reptile have been recorded within the reserve (Lopez Jurado, 1982), including green turtle Chelonia mydas (V), hawksbill turtle Eretmochelys imbricata (E), loggerhead turtle Caretta caretta (E), and leatherback Dermochelys coriacea (E), four of the six species occurring on Mexican coasts, and crocodile species Crocodylus moreletii (E) and C. acutus (E). Other species include Ctenosaura similis, Basiliscus vittatus, Thecadactylus rapicaudus, Boa imperator, Crotalus durissus, Bothrops asper, Bufo valliceps, Hyla staufferyi, H. microcephala, H. loquax and Leptodactylus melanonotus. Fish are abundant, and over 52 species have been recorded (Espejel, 1983). Zunino (1983) gives a preliminary evaluation of the invertebrate fauna reported from the coastal mangrove areas, and Gutiérrez Diaz and Canul Gonzalez (1983) give a preliminary report on the insects found in maize.

**CULTURAL HERITAGE** The reserve is located in the least developed part of the state of Quintana Roo, and the population is of predominantly Mayan origin practising subsistence agriculture and fishing (César Dachary and Lopez Ornat, 1983). Twenty-three Mayan sites have been recorded in the reserve, while Tulum, one of the most visited of Mexico's archaeological sites, the Chunchucmil ruins, Vigia del Lago and Xamach, are just to the north. Recently, a 24km-long Mayan artificial canal was discovered. Approximately 200 plant species represented in the reserve are used by the Maya (Consejo Duenas et al., 1987).

**LOCAL HUMAN POPULATION** There are reported to be some 800 inhabitants (principally of Mayan descent) living within the reserve. About 450 people live in the Javier Rojo Gomez settlement on Punta Allen, and a further 50 at Punta Herrero. Most of the rest (about 100) live in settlements ('rancherías') scattered on the coast and in the forest. Most inhabitants depend on fishing (and in particular of spiny lobster Panulirus argus), and there are some 75ha of maize fields, 1,352ha with livestock, and 760ha with copra (César Dachary and Lopez Ornat, 1983). There are also three manned lighthouses within the reserve, and a number of hotels and other tourist facilities.

**VISITORS AND VISITOR FACILITIES** Tourism began to develop around the 1970s when the Tulum beaches to the north started to attract foreign visitors, and visitor facilities have extended southwards, despite the lack of basic services, as trailer parks and rustic huts. However, the northern part of Quintana Roo has since become the second most important tourist centre in the country (Consejo Duenas et al., 1987) and further urban development is planned for the tourist corridor Cancun-Tulum, including Cozumel Island (Anon., n.d.a). In 1983, use of the area by tourists still appeared to be low, probably because of difficulty of access, isolation, and the lack of facilities (including good supplies of electricity and drinking water). Facilities throughout the reserve are restricted to the coastal strip. In the north this consists of a small hotel (Hotel Pez Maya), Boca Paila fishing club, and three areas for trailers and 'cabins', while elsewhere within the reserve there is only the small hotel and cabin area at Punta Pajaros. The northern sites can be reached by dirt track from Tulum, while Punta Pajaros is only accessible by boat or aeroplane.

SCIENTIFIC RESEARCH AND FACILITIES Scientific research is directed towards basic science and its application to the management and conservation of natural resources. Research in the area is coordinated by the Centro de Investigaciones de Quintana Roo (CIQRO), and extensive surveys have been carried out on different aspects of the wildlife, ecology, geology and hydrology (CIQRO, 1983). A team from the University of Mexico is currently evaluating the marine resources. In addition, various research institutions carry out research in the reserve (Consejo Duenas et al., 1987). Lodging is available for visiting scientists. To date there have been few meteorological records from the reserve itself, but two climatological stations have now been donated by the National Meteorological Service (SARH). El Ramonal experimental plot has been used to develop agricultural techniques that preserve the delicate Yucatan soil, using mixed cropping and crop rotation. Studies are also being carried out to ensure the sustainable exploitation of lobster and chit palm tree resources, both integral components of the local economy (Sheean-Stone, 1989).

CONSERVATION MANAGEMENT It has been suggested that Sian Ka'an is the largest effective nature reserve in Mexico, and the area has support at all government levels (municipal, state and federal). The decree in fact makes provision for a council involving the local community, a government coordinating committee and a technical research committee. A comprehensive management plan has been prepared in collaboration with the local population through a Council of Representatives. The plan proposes seven programmes to achieve the biosphere reserve objectives: administration, protection and monitoring of the reserve, natural resource management, public use, information, research and monitoring (natural resources and socio-economic) (Consejo Duenas et al., 1987). As a direct result of this local collaboration, several achievements have been made to date: control of immoderate felling of trees; considerable reduction in commercial hunting and indiscriminate use of forest products (central area); establishment of the basis for ecological regulations for the relocation of the Colonia Punta Herrero, which was considerably damaged by cyclones; and the contracting of local inhabitants from the area of Chunyaxché as reserve workers, and their collaboration in wild fauna captive breeding projects. The plan is comprehensive and provides for the zoning of the reserve for different management purposes. A private foundation, Amigos de Sian Ka'an, which consists of dedicated local people, is carrying out studies funded by the WWF. In March 1989, a rural training programme, part of the Amigos de Sian Ka'an's Regional Development Project, was initiated. A Public Information Project promotes the reserve through various media. Inaccessibility provides a certain degree of protection, but there are five unmetalled roads crossing the reserve where the margins are becoming increasingly disturbed.

Sian Ka'an is considered one of the least disturbed areas in Quintana Roo. Its forest cover is still intact and demographic pressure is low (Consejo Duenas et al., 1987). It has been considered a priority site for conservation (IUCN, 1980) and as an important ecosystem by Unesco (MAB, 1974). A series of evaluations of the reserve was carried out during 1989 which included aspects of its biology, ecology, as well as socio-economic and cultural. The creation of a Directive Committee for the reserve, and a foundation, has been suggested together with a series of recommendations (Anon., n.d.a; Anon., n.d.b).

MANAGEMENT CONSTRAINTS A particular concern is the development of tourist facilities in the north of the reserve. The seemingly uncontrolled urban growth along the coast, with inadequate sewage systems which discharge directly into the sea, seriously threatens surrounding reef life (Flores, 1989). Most tourist activities are planned for the area between Cancun and Tulum. Should these plans proceed, the coastline will be profoundly modified. Recent forest fires have



also occurred in this same area, affecting 135,000ha (Lopez Portillo et al., 1989), which, together with the regular occurrence of cyclones, emphasise the fragility of this ecosystem.

At present there is a 68km long coastal belt planted mainly with copra, with 25 small farms ('ranchos'). Forest exploitation is limited to the collection of useful wild plants and hunting for subsistence, although there is some commercial and sport hunting which should be regulated. Timber is also exploited with valuable species such as mahogany, cedar, 'siricote' and 'guayacan' becoming nearly exhausted through overexploitation. Chit palm Thrinax is a species much in demand for use in the construction of lobster traps. There may also be some impact from fishing, but the extent of this is unclear (although it is apparent that some lobster poaching continues). The surrounding communities are increasingly abandoning traditional ways in favour of more commercial practices that in time may threaten the reserve (Sheaan-Stone, 1989).

Due to its inaccessibility, monitoring, research, administration and active protection of the reserve is difficult (Consejo Duenas et al., 1987). In addition, there are only ten park rangers to patrol this huge area with the obvious limitations. Reserve boundaries are not easily defined, due to the existence of peripheral "ejidos", and thus their protection is difficult. Due to the high humidity, the cost of building and equipment maintenance is high. This is not helped by the high incidence of cyclones. Soil erosion is increasing in deforested areas. Potential pollution from Felipe Carrillo and Andres Quintana Roo ejidos exists, as these towns are within the hydrographic basin of the reserve and their effluent (domestic and industrial/agricultural) may penetrate the water table through absorption by calcareous soils. Water use should be controlled as excessive use could lead to increased salinity. Environmental legislation has recently been reviewed, but it still remains to be adequately enforced.

STAFF A director with a staff of 26, 16 of whom are qualified

BUDGET Government support is supplemented by funding from WWF-US to support protection of the area and some construction costs (to facilitate research). Conservation International and Ducks Unlimited (Mexico) also collaborate substantially (Consejo Duenas et al., 1987).

LOCAL ADDRESSES Secretaria de Desarrollo Urbano y Ecologia (SEDUE); Centro de Investigaciones de Quintana Roo, A.C., Puerto Morelos, Quintana Roo

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## MEXICO

NAME Reserva de la Biosfera Sierra de Manantlán

IUCN MANAGEMENT CATEGORY V (Protected Landscape)  
IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 1.21.12 (Madrean-Cordilleran)

GEOGRAPHICAL LOCATION Situated in the south-east of the State of Jalisco and in the north-east of the State of Colima; approximately 170km from Guadalajara and 52km to the north of Manzanillo, approximately 50km from the Pacific coast. Nearest towns are Autlan, Casimiro Castillo and Minatitlan. 19°26'-19°42'N, 103°51'-104°27'W

DATE AND HISTORY OF ESTABLISHMENT Established as a national biosphere reserve under federal legislation on 5 March 1987 and listed in the Diario Oficial of 23 March 1987 (Guzman Mejia and Lopez Zavala, 1987a). The site is now covered under the General Law of Environmental Equilibrium and Protection which came into force in March 1988 (SEDUE, 1989). The MAB Bureau approved its nomination as an international biosphere reserve on 27 January 1988 (Anon., n.d., a).

AREA 139,577ha; core area 41,901ha (Manantlán-Las Joyas 34,521ha, El Tigre 3,385ha, Cerro Grande 3,993ha) and buffer zone 97,676ha (Guzman Mejia and Lopez Zavala, 1987a).

LAND TENURE The core area is a mixture of state, community or 'ejidos', private and university/research station lands. The buffer zone lands are communal and private.

ALTITUDE 400m-2,960m

PHYSICAL FEATURES The reserve is situated in the transition of the Nearctic and Neotropical realms and encompasses part of the Sierra Madre del Sur, with a wide range of altitudes, climates and soils. The catchment area is large and contains a total of 18 basins each with characteristic erosive drainage patterns; only 3.5% of these have perennial flowing rivers. The main drainages are to the north, the rivers Ayuquila-Armeria, and to the south, the rivers Marabasco and Purificacion (Guzman Mejia and Lopez Zavala, 1987a; Jardel, 1989). Poor water absorption results in 45% run off of rains, causing extreme soil erosion and sediment build up in the valleys. Humidity is high, as a result of incoming sea mist, even during the dry season. The effect of tectonic and volcanic activities and erosion are notable within the reserve. There are batholiths, faults, as well as domes formed from ancient marine floors. The dominant topographic features are Cretacic (centre and west) and Cenozoic (high areas and north-west) igneous rocks which have formed a volcanic unit of mountains. There is a considerable number of rocks with different chemical compositions, a result of lava spills. Eleven different soil types and 85 different subtypes have been identified, with various substrates. Soils are not very fertile and are subject to erosion (Guzman Mejia and Lopez Zavala, 1987a).

CLIMATE Conditions vary from warm to temperate. At an elevation of 1,950m, mean annual temperature varies between 12°C and 23°C and mean annual rainfall is 1800mm. The rainy season may last for about six months (Guzman Mejia and Lopez Zavala, 1987a).

**VEGETATION** Eight different types of forests are present in the reserve including mesophytic, cloud, dry deciduous and semi-deciduous tropical forests. The main vegetation cover is oak Quercus, with pine-oak Pinus-Quercus and oak-pine Quercus-Pinus and Pinus-Abies forest associations appearing as altitude increases. Common pine species are Pinus douglasiana, P. duranguensis, P. herrerae, P. oocarpa and P. pseudostrobus. There are approximately 70,000ha of mesophytic forest in the country of which 20,000ha are found within the reserve (Guzman Mejia and Lopez Zavala, 1987a). Around 40 tree species have been commercially exploited for timber (Guzman Mejia, 1985). The flora is particularly rich with 1,958 species of plants (Jardel, 1989) and some 160 species of orchids. There are seventeen endemic species, of which the primitive maize 'teosinte' or 'chapule' Zea diploperennis is an important new species (Guzman Mejia and Lopez Zavala, 1987a) discovered in 1977 (Iltis *et al.*, 1979). Other important plants related to 'teosinte' are Tripsacum spp. and another wild maize Zea mays var. parviglumis (Anon., n.d., b). The genera Magnolia, Podocarpus, Trichopteris and Talauma are representatives of living fossil flora (Guzman Mejia and Lopez Zavala, 1987a). Epiphytes such as orchids, ferns, bromeliads and cacti are abundant (Anon., n.d., b). Further details of the flora can be found in Guzman Mejia (1985).

**FAUNA** A wide variety of species is present with over 20 amphibians, 60 reptiles, 336 birds (representing 30% of all bird species in the country), 108 mammals (25% of Mexico) and 16 fishes (Sheean-Stone, 1989). Mammals include all six species of cat found in the country such as jaguar Panthera onca (V), ocelot F. pardalis (V), puma F. concolor and jaguarundi F. yagouaroundi (I). Otter Lutra longicaudis, white-tailed deer Odocoileus virginianus, collared peccary Tayassu tajacu, giant Mexican shrew Megasorex gigas, Collie's squirrel Sciurus colliae and Mexican vole Microtus mexicanus neveriae are also found. Birds include military macaw Ara militaris, lilac-crested Amazon Amazona finschi, crested guan Penelope purpurascens and golden eagle Aquila chrysaetos (Guzman Mejia and Lopez Zavala, 1987a).

**CULTURAL HERITAGE** The region is known by anthropologists as "Zona de Occidente" (West Zone), an area notably different to the rest of Mesoamerica. Some ceramic remnants, figurines and graves have been found but there is little other material evidence. It is conjectured that the area was inhabited by an indigenous group known as the Otomi before the Spanish conquest. Since their houses were made with roots, branches and mud, which would have long since decayed, no remains have been found. These people depended on the forest for food, clothing and shelter; they extracted soft fibres from the 'maguey' (agave) and cotton. Maize, chilli and fruits were the main crops before and after the conquest. Cattle were introduced to the area in the 18th century and became important after the revolution in 1910. A detailed anthropological study still remains to be done within the reserve (Guzman Mejia and Lopez Zavala, 1987a).

**LOCAL HUMAN POPULATION** Approximately 32,000 people live in the Sierra de Manantlán (Anon, n.d., b), of whom around 5,000 live permanently within the buffer zone and 10,000 within the transition zone. Agriculture appears to be their main livelihood (Guzman Mejia and Lopez Zavala, 1987a). The living conditions of these people are poor and marginal. Being one of the forgotten groups in Jalisco, their land rights have been ignored by commercial timber companies and by local caciques (Anon., n.d., b). Although commercial logging is no longer permitted in the core area, there are large mounds of sawdust, several metres high, marking the sites where sawmills and villages once stood during almost 40 years of logging which began in the 1940s (Sheean-Stone, 1989); 414,987 cubic metres of timber were extracted from 1961 to 1976 (31,918 c.m. per year) (Jardel, 1989). The Sierra distributes large volumes of water into the valleys throughout the year and it is

tapped by over 400,000 people living within the reserve's area of influence. 'Teosinte' Zea diploperennis is believed to be a potential 'food of the future' as it is the only wild species found to be resistant or immune to the seven major corn viral diseases (Sheean-Stone, 1989). There are some human settlements in the transition zone, and, besides subsistence activities, major activities include agriculture (corn, beans, tomatoes, sugarcane, watermelon, mangoes), livestock grazing, timber production, extraction of wood for fuel and mining of coal or minerals. Fishing or shellfishing, recreational activities, tourist development, agroforestry projects and aquaculture are also listed in decreasing order of magnitude (Anon., n.d., a; Guzman Mejia and Lopez Zavala, 1987a).

VISITORS AND VISITOR FACILITIES Tourism occurs but is minor (Guzman Mejia and Lopez Zavala, 1987a).

SCIENTIFIC RESEARCH AND FACILITIES Long-term ecological studies and conservation projects are being undertaken on Zea diploperennis and similar species as well as on habitat, mammal and bird conservation. There is an integrated programme for basic and applied land use and site management objectives and sustainable conservation in the region (Guzman Mejia and Lopez Zavala, 1987a). Other ongoing research activities include biological surveys and collections, comparative ecology, ecological succession, ecosystem restoration, ethnobiology, fire history and effects, forest research, genetic resource management, limnology and hydrobiology, pests and diseases, resource mapping, soil studies and conservation, traditional land use systems and environmental education. Planned activities include studies on rural technology, biogeochemical cycles, cultural anthropology, hydrological cycles, rangeland management, rare and/or endangered species, soil studies and conservation, watershed management and wildlife population dynamics (Anon., n.d., a; Guzman Mejia and Lopez Zavala, 1987a).

There is a biological research station in the core area and two additional offices on the northern border of the reserve (town of El Grullo), while a fourth is located in the remote village of Cuzalapa. Because of its extensive and growing database, and the success of its activities within the reserve, the Laboratorio Natural Las Joyas has become the most important research laboratory in western Mexico (Sheean-Stone, 1989). Approximately 10 national and 20 foreign scientists participated in research during one year (Guzman Mejia and Lopez Zavala, 1987a).

CONSERVATION VALUE The biosphere reserve was established to protect an area of outstanding beauty and scientific importance and its considerable area of influence.

CONSERVATION MANAGEMENT It is under long-term legal protection (Anon. n.d., b). It aims to preserve the natural ecosystems and genetic resources of the area by encouraging habitat regeneration of disturbed areas; maintaining biological diversity; protecting threatened species and by providing the legal and administrative basis for resource protection and management. Research and long-term monitoring programmes, promotion of integrated rural development, local participation, environmental education, information exchange and recreational activities are also outlined objectives. The importance of Sierra de Manantlán was highlighted by the discovery of the endemic Zea diploperennis, a disease-resistant primitive maize (Guzman Mejia and Lopez Zavala, 1987a). It is also hoped that the establishment of the area as an international biosphere reserve will prevent further abuse of the resources and will give back nominal land rights to local people (Anon. n.d., b).

A plan of operation (plan operativo) and its summary detail all activities in the

reserve and in its area of influence (Guzman Mejia and Lopez Zavala, 1987a and b). The core area is under strict protection and the following activities occur or have occurred: collection of plant material, ecological observations and surveys, environmental education, long-term environmental monitoring, professional training and collection of blackberries, mushrooms, freshwater shrimp and firewood by the local population (Anon., n.d., a; Guzman Mejia and Lopez Zavala, 1987a). An area of 1,250ha has been fenced off to safeguard against cattle and slash-and-burn cultivators (Sheean-Stone, 1989). The buffer zone has similar status as the core area although there is no information on uses or activities within it. In the transition zone, agriculture, livestock grazing, timber production, extraction of wood for fuel, mining of coal or minerals, fishing, recreational activities, tourist development, agroforestry projects and aquaculture occur (Anon., n.d., a; Guzman Mejia and Lopez Zavala, 1987a). Forest regeneration is now taking place, with pine species recovering first followed by hardwood species (Sheean-Stone, 1989).

A workshop to analyse a conservation strategy for the reserve prepared by personnel of the Laboratorio Natural Las Joyas was held during August 1989. Three planning levels were proposed: a) integral management programme, b) management plans for the reserve subunits and c) annual operative plan which will define actions and funding by official institutions (Jardel, 1989). A doctor and a veterinary surgeon are provided free to the community by the Laboratorio Natural Las Joyas. In addition, a community health clinic provides traditional remedies and advice to the community based on the indigenous knowledge of medicinal plants (Sheean-Stone, 1989).

**MANAGEMENT CONSTRAINTS** Unauthorized cattle grazing and poaching occur in the core area. In the transition zone other potentially detrimental activities such as poaching, cattle ranching, hunting, industrial development and land conversions occur. Urban centres are also present. Some of these activities may well go beyond the limits established by the reserve regulations. In general, serious problems in the reserve include overgrazing by cattle throughout the whole area, forest fires, felling, soil degradation, loss of genetic resources, poaching (Guzman Mejia and Lopez Zavala, 1987a; Jardel, 1989), legal boundaries of privately owned land, illegal cultivation of marijuana (*Cannabis sativa*) and opium poppy (*Papaver somniferum*) and hunting of wildlife. In the case of cattle ranching, the situation is aggravated as the livestock usually belong to people who do not live in the area but rent the land as pastures. By excluding the cattle from core areas potential problems may occur with the inhabitants due to a loss of income (Guzman Mejia and Lopez Zavala, 1987a).

**STAFF** Totals 67, of whom 20 are research scientists, 15 administrative personnel and 32 are technical support personnel for research.

**BUDGET** Financial support is received from national and international bodies. National institutions include the Universidad de Guadalajara, Gobierno de Jalisco, National Council for Science and Technology (CoNaCyT), Ministry of Urban Development and Ecology. International agencies include WWF-US, WWF-INT, IUCN, Nature Conservancy and Conservation International. The total budget needed in 1987 was \$843,600,000 Mexican pesos (US\$312,444, approximate 1990 exchange rate). Of this total, \$131,500,000 (US\$48,703) were required for administration; \$12,420,000 (US\$4,600) for planning; \$37,315,000 (US\$13,820) for management of natural resources; \$193,908,500 (US\$71,818) for research and monitoring; \$16,601,700 (US\$6,149) for ecodevelopment; \$93,037,500 (US\$34,458) for broadcasting and \$256,580,000 (US\$95,030) for field work (Guzman Mejia and Lopez Zavala, 1987a).

LOCAL ADDRESSES Universidad de Guadalajara, Laboratorio Natural Las Joyas de la Sierra de Manantlán, Apartado Postal 1-3933, Guadalajara, Jalisco, CP 44100

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## MEXICO

NAME Reserva de la Biosfera de Mapimí

IUCN MANAGEMENT CATEGORY IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 1.09.07 (Chihuahuan)

GEOGRAPHICAL LOCATION Situated north-east of the town of Ceballos on the boundaries of the states of Durango, Chihuahua and Coahuila. The reserve lies in a hollow or basin surrounded by small mountain ranges running more or less parallel from north to south, in the large catchment area known as Bolson de Mapimí. The core area consists of Rancho San Ignacio: Cerro San Ignacio, Cerro el Tapado, Cerro Amarillo and el Sur del Espinazo de Diablo; Ejido de la Flor: Cerro Apartado, Cerro Coronas and San José del Centro; Ejido San Ignacio del Yermo. The buffer zone consists of El Ejido de la Flor, Ejido de la Soledad, Ejido de Santa Maria de Mohovano, Ejido Vicente Guerrero and Ejido de la Loma. The zone of influence includes Ejido el Cinco, Ejido las Tortugas, Ejido la Soledad, Ejido del Yermo, Estacion Carrillo and the Rancho San Felipe. 26°29'-26°52'N, 103°40'-103°56'W

DATE AND HISTORY OF ESTABLISHMENT January 1977 as a biosphere reserve

AREA 103,000ha (expanded from original 100,000ha; core area 38,000ha)

LAND TENURE There are various common public lands, private ranches and small peasant properties.

ALTITUDE 1,100m-1,350m

PHYSICAL FEATURES The reserve is part of the endorheic system of the Mapimí Bolson of the North Mexican Central Tableland and part of the Chihuahuan Desert. Alluvial deposits predominate, consisting of recent Pleistocene gravels, clays and muds. Outcrops of igneous rock from the Tertiary period and volcanic rocks (rhyolites, andesites and basalts) are also found. There are isolated mountains and extensive interconnected plains, and a spring in the core zone (IUCN, 1982; Bartolino, 1988).

CLIMATE An arid desert-like tropical highland climate with short but heavy periods of rain, and mean annual rainfall of 200mm. Mean monthly temperature varies between 11.2°C and 28.4°C, with a minimum of 1.5°C in January and maximum of 50°C in July-August.

VEGETATION The reserve is located in the Chihuahua arid zone, typically represented by a restricted flora with a large number of endemics. The main vegetation types represented include mequital, matorral crasicaule-nopalera, rosetophyllous matorral, microphyllous matorral and pastizal (Montana and Breimer, 1988). Microphyllous matorral shrub is the most representative vegetation community, as characterised by Agave and Larrea divaricata, together with fleshy-leaved species Agave spp., Hechtia spp., thick-stemmed species Pastinaca spp., candelilla Euphorbia antisyphilitica and prickly pear Opuntia spp. Large expanses of mesquite Hilaria mutica and drop seed Sporobolus airoides occur in the bottom lands (IUCN, 1982; Montana and Breimer, 1988).

FAUNA The diverse fauna is adapted to arid conditions and includes Bolson



tortoise Gopherus flavomarginatus (E), mule deer Odocoileus hemionus, coyote Canis latrans, lynx Felis rufus and puma F. concolor. Prong-horn antelope Antilocapra americana disappeared in the 1940s. Birds include turkey vulture Cathartes aura, American kestrel Falco sparverius, golden eagle Aquila chrysaetos, ladder-backed woodpecker Picoides scalaris (Anon., 1989).

CULTURAL HERITAGE No information

LOCAL HUMAN POPULATION In the early 1980s there was a total population of approximately 100 people (Halffter, 1981). Of the main ranch and farm units in the reserve at this time, three were privately owned while eight were ejidos in which the land was entrusted by the government to a local community. Nine of the units were devoted to stock-raising, one to the extraction of wax from candelilla, whilst 11 extracted salt from a lagoon to the north of the reserve. Agricultural development is rudimentary for the most part and the availability of water varies widely (IUCN, 1982). Efforts have been made to involve the local inhabitants both through the application of results of research within the reserve to stock-raising practices, and by ensuring that the protection of the reserve is their responsibility (IUCN, 1982).

VISITORS AND VISITOR FACILITIES No information

SCIENTIFIC RESEARCH AND FACILITIES Research since 1975 has primarily been undertaken in the core area of Rancho San Ignacio and Ejido de la Flor (Instituto de Ecología, in litt., 1988). Facilities include the Desert Laboratory, established in 1978 by the Instituto de Ecología and located in 20ha of land in the centre of the reserve (Halffter, 1981). Several institutions, foreign and domestic, are undertaking a large number of studies (see Montana, 1988). Examples include the study of herpetofauna, ecophysiology of dominant reptile species, the biology of the desert tortoise, the biology of raptorial birds, and regeneration of desert vegetation after over-grazing, fire and various types of human activity. With the help of associations of bee-keepers, it is planned to subsidise certain young "ejidatarios" (communal farmers) so that they can learn the techniques of desert bee-keeping practices. There is a camp near the only spring in the zone at San Ignacio. Light aircraft and motor vehicles are available from the Government of the State of Durango and camping equipment has been provided by the Secretariat for the National Heritage (Halffter, 1981).

A comparative study between the biosphere reserves of Mapimí and Nacunan (Argentina) took place in Mapimí during September and October 1989 as part of an exchange programme between the two countries (Abraham de Vazquez, 1989). In addition, representatives of Big Bend and Jornada biosphere reserves in the USA have also been invited to participate in these exchange programmes (Aguirre in litt., 1989). A binational (ORSTOM, France and Instituto de Ecología, Mexico) symposium on the relationship water-soil-vegetation and cattle in the arid zone of northern Mexico was held in October 1989 in Durango (Maury, in litt., 1989).

CONSERVATION MANAGEMENT Established primarily to protect Bolson tortoise and the delicate arid wildlife communities. Activities include livestock ranching, fire management and wax extraction from plants. When the reserve was first established there was no zonation but this has subsequently been undertaken, centred on Rancho San Ignacio and Ejido de la Flor. The federal government, through the National Council of Science and Technology (CONACYT) and the Secretary of Public Education (SEP), was involved in the establishment. The scientific management of the biosphere reserve is coordinated by the Instituto de Ecología. The local people are involved in a legally constituted association to assist in management of the

reserve. This group includes representatives of the cattle ranches, small land-owners, ejidos and the National Council of Science and Technology and the Instituto de Ecología. Cooperation with the local people has resulted in reducing cattle ranching to less damaging and more sustainable levels (Halffter, 1981; Barral, 1988; Instituto de Ecología, in litt., 1988). The Instituto de Ecología has proposed to enlarge the biosphere reserve from its current area to 160,000ha (Instituto de Ecología, in litt., 1988).

**MANAGEMENT CONSTRAINTS** The region has been little disturbed, except for sporadic hunting and, to a lesser degree, extensive stock raising, and cutting of trees (Barral, 1988).

**STAFF** Fourteen research workers, eight research assistants and technicians, and seven students engaged in research work (IUCN, 1982).

**BUDGET** No information

**LOCAL ADDRESSES** Instituto de Ecología, Apartado Postal 18-845, Mexico 18, DF

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## NETHERLANDS

NAME Wadden Sea Area

IUCN MANAGEMENT CATEGORY

I (Strict Nature Reserve)

IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 2.09.05 (Atlantic)

GEOGRAPHICAL LOCATION Lies in the provinces of Noord-Holland, Friesland and Groningen (80-200km north to north-east of Amsterdam). With the exception of the Lauwersmeer area, the boundary of the biosphere reserve coincides with the border of the "Planologische Kernbeslissing" (PKB) ("Physical Planning Key Decision") in which the governments policy with regard to the Wadden Sea has been laid down. In places where there is no sea barrier the boundary includes all forelands which are inundated by high tide at least once in every two years. This policy means that the boundary does not necessarily coincide with existing nature reserves. The Lauwersmeer area covers an area of estuary on the north coast of the mainland. 52°52'-53°33'N 04°45'-07°13'E

DATE AND HISTORY OF ESTABLISHMENT Parts of the site are protected under the Nature Conservancy Act 1967, the following sites have also been protected under decrees passed on the following dates: Boschplaat - Terschelling (8 November 1974), Dollard Kwelders en Wad (23 May 1977), Staatsnatuurreservaat De Dollard (19 October 1978), Staatsnatuurreservaat De Waddenzee (18 May 1981), De Schorren en Vlake van Kerken, Texel (23 July 1982), Kwelders Noordkust Friesland (23 July 1982) and Kwelders Noordkust Groningen (22 July 1982) (Anon., 1986). Virtually the whole area was designated as a wetland of international importance under the Ramsar Convention on 2 May 1984. The area of the Lauwersmeer protected for nature (4,300ha) has been designated as "Grote Eenheid Natuurgebied" (GEN) (Large Nature Area Unit); the legal basis of this designation is, however, rather weak. Accepted as a biosphere reserve in October 1986 (Anon., 1986).

The Wadden Sea wetlands cover not only the Netherlands coast, but also the North Sea coast of Germany, and much of the coast of Denmark. Wadden Sea Ramsar sites are found in all three countries. Trilateral agreements were thus deemed to be important for the protection of the region as a whole. The first attempt, under the initiative of the Netherlands IUCN, in 1974 was largely unsuccessful, but later, in 1978 and 1980 agreements were signed. In 1982 the Wadden Sea states signed the 'Joint Declaration on the Protection of the Wadden Sea' (Zweip, 1987; Anon., 1990c).

AREA Total area 260,000ha, core area 120,000 ha. The Ramsar site covers 250,000ha. The following of sites are afforded differing degrees of protection: Boschplaat, Terschelling (4,400ha), Dollard Kwelders en Wad (4,320ha), Staatsnatuurreservaat De Dollard (1,005ha), Staatsnatuurreservaat De Waddenzee (101,000ha), De Schorren en Vlake van Kerken, Texel (6,700ha), Kwelders Noordkust Friesland (670ha), Kwelders Noordkust Groningen (1,220ha) (Anon., 1986).

LAND TENURE 107,000ha of the core area are state property and the remaining 13,000ha are private property. Sites declared "Staatsnatuurreservaat" are state owned areas. Nature conservation societies own and/or manage 11,000ha of the private property. Natuurmonumenten, a non-governmental nature conservation organisation, manages about 12,000ha in and around the Waddensea (Anon., 1986).

## ALTITUDE 0-7m

PHYSICAL FEATURES The Wadden Sea is a shallow coastal sea, partly estuarine in character. It is protected from the North Sea by a chain of islands and high sand flats. The Wadden Sea consists of tidal channels and shallow open water (about 45% of the area), muddy and sandy tidal flats (about 45%) and salt marshes (about 10%). Rising sea levels are constantly pushing the coastline landwards, but this effect is countered by a constant reshaping of the coast by currents and deposition (Zwiep, 1987). The most eastern part of the Dutch Wadden Sea is marked by the estuary of the Ems River (Anon., 1986).

CLIMATE Conditions are Atlantic with a mean annual temperature of 9.1°C and mean annual precipitation of 720mm at sea level.

VEGETATION The salt marshes are covered with halophilous vegetation with some 30 species of phanerogams. Transitional areas between marshes and dunes support a further 100 species. The tidal flats support only two species of seagrasses Spartina spp., but dozens of species of macro-algae and hundreds of micro-algae. Very little vegetation grows in the tidal channels (Anon., 1986).

FAUNA The tidal channels and flats support a broad and highly productive assembly of invertebrates; notable examples include copepod Temora longicornis, jellyfish Aurelia aurita and Rhizostoma pulmo, lugworm Arenicola marina, ragworm Nereis diversicolor, blue mussels Mytilus edulis, cockle Cerastoderma edule, baltic tellin Macoma balthica, sandgaper Mya arenaria, shore crab Carcinus maenas and common shrimp Crangon crangon (Dankers, Kuhl and Wolff, 1981). These animals form the staple food for numerous species of fish and birds. The Wadden Sea is one of the major nursery areas for many North Sea fish species, including species caught commercially: 80% of commercial plaice stocks; 50% of commercial sole stocks and 40% of commercial herring stocks spend part of their juvenile stages in the Wadden Sea, giving it major economic importance. It is estimated that between six and twelve million birds pass through the area each year and the area plays a vital role in the lives of about 50 species. The Wadden Sea is a very important migratory route for waterfowl and about 1 million birds may be present at any one time. Groups of waterfowl which use the area include geese, ducks, waders, terns and gulls. Breeding species found within the biosphere reserve include redshank Tringa totanus, common tern Sterna hirundo, shelduck Tadorna tadorna, eider Somateria mollissima, oystercatcher Haematopus ostralegus, avocet Recurvirostra avosetta, Kentish plover Charadrius alexandrinus, hen harrier Circus cyaneus, spoonbill Platalea leucorodia, pintail duck Anas acuta and sandwich tern Sterna sandvicensis (Grimmett and Jones, 1989). Grimmett and Jones (1989) provide a summarised list of the more important bird species and their frequencies in the area. The only large aquatic mammal species frequently occurring in the area is harbour seal Phoca vitularia (Anon, 1990c; Zweis, 1987).

CULTURAL HERITAGE Man has used the fertile borderland for thousands of years, and constantly tried to protect himself, his crops and his livestock from the sea. Dykes were first built in the Middle Ages. Major floods between the 14th and 17th centuries destroyed most of the land and settlements, drowning thousands of people (Zwiep, 1987). Traditional uses of the Wadden Sea still in practised today include fishing and harvesting of shellfish (especially mussels) and lugworms.

LOCAL HUMAN POPULATION Land adjacent to the Wadden Sea supports an agricultural community, most of the coastal strip having a very low population density. Concentrations of population occur in the harbour towns of Den Helder (60,000 residents), Harlingen (15,000 residents) and Delfzijl (25,000 residents) (Bruning,

1981). Harlingen employs people in industry and increasingly in tourism; the Eems haven includes a harbour and an industrial area.

**VISITORS AND VISITOR FACILITIES** The area and the islands attract a substantial number of tourists. Visitor activity is mainly limited to the edges of the reserve, including sailing, angling, walking on the tidal flats, windsurfing and birdwatching (Bruning, 1981). Facilities for visitors include camp sites and hotels and service industries have developed. There are about 30 million overnight stays in hotels on islands such as Norderney in the Wadden Sea (Danish, Dutch and German parts) (Anon., 1990c).

**SCIENTIFIC RESEARCH AND FACILITIES** The Wadden Sea has been the site of scientific research for at least 100 years. In 1985 about 50 scientists conducted research in the area. It is expected that such research effort will be maintained in the future. Located very close to the area are two research laboratories, three field stations and a number of shelters. There is accommodation for 40 scientists (Anon., 1986). The effects of harvesting of lugworms Arenicola marina has been investigated by Van den Heiligenberg (1987).

**CONSERVATION VALUE** Owing to its size, location and character the Wadden Sea as a whole is one of the world's most productive border seas. Increasing pressure on coastal habitats has led to the situation now where it represents 60% of all tidal flats to be found in Europe and North Africa (excluding mangrove areas), and contains 20% of Europe's salt marshes (Zweip, 1987). It is also one of the major nursery areas for many North Sea fish species, including species caught commercially. It is a vital stopover for waterfowl on the Western Palaearctic migration route. Together with its rich breeding populations of birds and seals this makes the Waddensea the single most important wetland in Western Europe (IUCN 1987).

**CONSERVATION MANAGEMENT** In 1982 the Wadden Sea states signed the 'Joint Declaration on the Protection of the Wadden Sea'. In this they agreed to cooperate on the implementation of the most important international agreements for the protection of nature in the Wadden Sea: the Convention on the Conservation of European Wildlife and Natural Habitats (Bern, 1982); the Ramsar Convention (Ramsar, 1971); the Convention on the Conservation of Migratory Species (Bonn, 1979) and the EC-Bird Directive (79/409/EC). In 1987 the Wadden Sea states established the Common Wadden Sea Secretariat, designed to support and strengthen the cooperation for the protection of the Wadden Sea by collecting information on threats and conservation efforts, by analysing this information and the legal structures for protection within each country, by disseminating information about the region and by providing support for scientific programmes and for trilateral meetings and conferences (Zweip, 1987; Anon., 1990c).

Nature conservation societies own and/or manage 11,000ha of the private property within the core area, including the Dollard estuary, Kwelders Noordkust Friesland and Kwelders Noordkust Groningen. Natuurmonumenten, a non-governmental nature conservation organisation, manages about 12,000ha in and around the Waddensea including large parts of the Dollard, the island of Griend, reserves near the Lauwersmeer and on the islands of Tessel and a small area on Terschelling (Anon., 1986). Most coastal reserves are closed to the public, at least during the breeding season, although enforcement of this is not always successful (Grimmett and Jones, 1989). Measures are being taken to restrict the number of breeding pairs of herring gull Larus argentatus. Management programmes include the Wadden Sea Conservation Programme (WWF Project 1411) which operates through the IUCN/WWF Advisory Committee for the Wadden Sea. The committee outlined a strategy for the

area, developed a long-term programme for identifying priorities and provided recommendations on critical conservation issues in order to maintain and improve the status of the area. Projects are funded by the three national WWF organisations concerned (Denmark, Germany and the Netherlands). There is a management plan for the reserve. Wardens and other government officials are responsible for controlling human activities such as fisheries, recreation and sand extraction. The most active management is carried out in the coastal areas of salt marsh and dunes. Very vulnerable parts of the reserve, e.g. breeding colonies of birds and seal resting areas which together comprise 10% of the area, are afforded strict protection. In the remaining part of the core area, fishing and recreation are permitted unless such activities threaten the integrity of the area. Outside the core area other activities such as sand extraction and mussel culture are allowed, subject to safeguards.

MANAGEMENT CONSTRAINTS The greatest ecological threat is declining water quality. Pollution, mainly originating from the River Rhine, comes in the form of waste water, heavy metals, pesticides and polychlorinated biphenyls. Fish diseases, bird deaths, reduced fertility in seals and algal blooms have all been related to the high degree of pollution in the area. In the summer of 1988 about two-thirds of the seal population died as a result of the virus Phocine distemper. It has been suggested, although not proven, that this disease may have resulted from pollution (Anon., 1989). In any case their bodies were reported to be so heavily polluted they had to be treated as chemical waste (Anon., 1990a). Atmospheric pollutants, acidifying, photochemical, greenhouse and ozone-destroying gases are also present. Military training occurs in some areas adjacent to protected areas, for example the Marnewaard training area adjacent to the Lauwersmeer site and there is an ammunition factory nearby (Grimmett and Jones, 1989). Other disturbances are fishing, mussel culture, sand extraction, exploitation of petroleum and engineering works for coastal protection. Grimmett and Jones (1989) state that subsidence of the small island of Griend in the centre of the reserve is partly due to nearby gas exploration. The area is affected by mass recreation (Anon., 1990a), and, although most coastal reserves are closed to the public during the breeding season, enforcement of this is not always successful (Grimmett and Jones, 1989).

The future of the area as habitat for birds also depends on maintaining the productivity of the area as a food source. Van den Heiligenberg (1987) considered the present level of harvesting lugworm as not enough to be detrimental to the food levels available to bird populations. More concern was raised over the disturbance to feeding birds caused by the presence of people digging for lugworm causes. Some areas are now permanently unsuitable for feeding birds despite supporting an available food source.

In 1988 the WWF and the IUCN issued a joint declaration to the three governments of Denmark, Federal Republic of Germany and the Netherlands, stating that a significant number of the commitments made by these states in their 1982 Joint Declaration on the Protection of the Wadden Sea were not being met. They also urged them to intensify and integrate their measures to protect the Wadden Sea (Anon., 1988).

The National Report of the Netherlands on the implementation of the Ramsar Convention, prepared for the Montreux Conference 1990, contains many references to the problems facing the Wadden Sea. A document prepared by eight non-governmental organisations (Anon, 1990a) considers this report "rather too positive". It states that the Dutch government "is unnecessarily impeding the protection of wetlands and...is violating both the spirit and the text of the

Ramsar Convention"; their attempts to reclaim a 900ha of the Wadden Sea were recently thwarted by the Dutch Society for the Protection of the Wadden Sea in Court, they have also been condemned twice by non-governmental organisations for not fulfilling their obligations under the EEC Birds Directive (Anon., 1990a).

Although local governments have a potentially major role to play in wetland conservation, a recent survey by Dutch non-governmental organisations showed that 44% of the municipalities that have international wetlands within their boundaries are not aware of that fact, and that there is remarkably little cooperation between administrative regions. As a result, the Dutch Wetlands Task Force, a group of non-governmental organisations, produced a brochure describing the importance of wetlands, the Ramsar Convention and the relevant legislature, coupled with an appeal to local governments to take initiatives: this received partial government funding and has been widely circulated. It has been followed up by a series of one-day symposiums in local areas which have been well attended (Anon., 1990b).

The continued ecological functioning of the Wadden Sea is also strongly dependent on conditions within the rest of the North Sea. At the Third North Sea Conference in the Hague in 1990, the Wadden Sea states all called for the phasing out of PCBs and the reduction of other harmful pollutants as soon as possible. They also requested measures to reduce atmospheric pollution around the North Sea (Anon., 1990c).

STAFF One hundred and eight staff, including 12 research staff (Anon., 1986)

BUDGET WWF Expenditure on Waddensea Conservation Programme (Project 1411) 1984/85 - \$2,523 (total since 1977 - \$492,080)

LOCAL ADDRESSES Staatsbosbeheer, Engelsekamp 6, 9722 AX Groningen

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## PHILIPPINES

NAME Palawan Island Biosphere Reserve

IUCN MANAGEMENT CATEGORY IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 4.26.13 (Philippines)

GEOGRAPHICAL LOCATION An island, comprising the Province of Palawan, to the south-west of the main Philippines archipelago and close to the northern coast of Sabah. Bounded by the Sulu Sea to the south and east and the South China Sea to the north and west. The biosphere reserve includes the main island, Busuanga and Culion islands to the north, Tubbatha Reefs to the east and Balabac Island to the south. 8°30'-12°45'N, 117°30'-121°45'E

DATE AND HISTORY OF ESTABLISHMENT Approved as a biosphere reserve in February 1990. Palawan Wildlife Sanctuary was established in 1967, St Paul's Subterranean River National Park (1971), Ursula Island Bird Sanctuary (1960), Babumbayan Experimental Forest (NA) and Tubbataha Reefs National Marine Park (1988).

AREA 1,150,800ha. Comprises core area (55,625ha), buffer zone (636,550ha) and transition area (458,625ha). Palawan Wildlife Sanctuary covers 763,399ha, St Paul's Subterranean River National Park (3,901ha), Ursula Island Bird Sanctuary (20ha), Babumbayan Experimental Forest and Tubbataha Reefs National Marine Park (33,200ha).

LAND TENURE Tenure is held principally by the national government, the provincial government and local government, as well as by institutions and private individuals (Anon., 1990).

ALTITUDE Ranges from 180m below sea level to 2,085m (Mount Mantalingajan).

PHYSICAL FEATURES Palawan Province comprises 1,768 islands, dominated by the south-west to north-east oriented main island which extends for 425km with a width of 5km to 40km. Associated archipelagos include the Calamian Group to the north, the Cuyo islands to the north-east, the Cagan islands to the east, the Kalayan islands in the west and Balabac islands in the south. In addition, smaller island clusters are found at Honda Bay, Bacuit Bay, Green Island, San Pedro Bay and Sharks Fin Bay. With the exception of the Cagayan and Kalayaan islands all these are on the Sunda shelf concurrent with Borneo.

Palawan is dominated by a central mountain spine extending its entire length, the highest peak being Mt Matalingajan in the south, and terminating in steep, low hills and narrow coastal plains (Anon., 1990). Some 47% of the land mass has a slope angle greater than 30°, and a further 19% has a slope angle of between 18-30°. Lowlands and swamplands constitute less than 20% of the land area (HTS, 1983). This results in the numerous small to medium-sized watersheds drained by short river systems. The longest river is the Babuyan, 54km in length, while the largest catchment is the Ilian River catchment with an area of 332 sq.km. Four geological regions can be distinguished on Palawan Mainland, namely north of St Paul's, between St Paul's and the Quezon-Aboabo gap, south of the Quezon-Aboabo gap, and the lowland fringe within the first three regions. The region north of Mount St Paul is dominated by metamorphic rocks of the basement complex, with volcanics around Cleopatra's Needle and the sedimentary Bangley Formation in the west. Slightly metaphorsed limestone forms the impressive karst landscape around

Mount St Paul and El Nido Cliffs. Central Palawan is mainly underlain by ultramafic rocks giving rise to poor soils and vegetation cover. South of the Quezon-Aboabo gap, the ultramafic outcrops are mixed with undifferentiated volcanic and tertiary limestone. Tertiary sandstones and shales occur along the south-west coast. The lowland fringe of alluvial plains and terraces are extensive along the south-eastern half of the mainland such as the plains of Narra, Aborlan and Brookes Point. These are virtually absent in the north except around Abongan. The tectonic history of Palawan is complex, with uplift, subsidence, tilting and faulting, and some 27 earthquakes were recorded during 1945 to 1975, indicating on-going tectonic activity (HTS, 1983).

**CLIMATE** From January to April the climate is influenced by the cool and stable north-easterly winds. In May, the warm and unstable south-west monsoon predominates until November and December when the North Pacific Trade Winds and north-easterly airflows predominate. Rain falls from May to December, particularly on the west coast where 7-9 wet months with more than 200mm per month and only 2-3 dry months (less than 100mm) are experienced annually. Large areas in the east are shielded by the mountains with only two wet months, up to four dry months and 5-8 intermediate months (100-200mm). Mean annual precipitation at 4m a.s.l. ranges from 1600mm on the east flank and 3000mm on the west flank. The mountains may receive up to 5000mm annually. Maximum mean monthly temperature is 29°C and minimum mean monthly temperature is 27°C. Diurnal temperatures range from 22.5°C to 31.4°C during February and 24.5°C to 31.4°C during May.

**VEGETATION** The island still has substantial areas of both tropical lowland and montane forests, concentrated mainly in the south and southwest of the island, with a total of some 780,000ha (68%) covered by forest and 371,000 ha (32%) unforested on the early 1980s (HTS, 1983). More recently, a figure of 65% forest cover for the entire province has been reported (Pido, 1988). Forests in Palawan are quite distinct from those in the rest of the Philippines, resembling formations found in Sabah and Northern Kalimantan.

On the basis of Landsat imagery capture during 1979, six forest sub-formations can be distinguished as follows: evergreen rainforest (31% of mainland area), drier, semi-deciduous forest (29%), Casuarina forest (0.2%), montane forest (0.8%), scrub forest (2%) and mangrove (4%). Evergreen rain forest comprises productive Dipterocarp forest on the wetter western mountain slopes and in the north. Drier semi-deciduous forest has variable species composition, and occurs on eastern rain-shadow mountain slopes and on poor soils of ultramafic rocks of central Palawan. Casuarina forest, dominated by C. rumphiana, is found on poor lowland soils and on steep upland slopes. Montane communities comprise stunted low mist or cloud forest above 1,200m altitude. Scrub forest occurs as natural formations on limestone and as regenerating communities. Mangroves, dominated by Rhizophora spp., Nypa fruticans and other species, are found on tidal flats and shallow bays or estuaries (HTS, 1983).

**FAUNA** Palawan is noteworthy for its rich fauna (relative to island size), including many groups (carnivores, pangolins, porcupines and some insectivores) absent or poorly represented elsewhere in the Philippines. Although many mammal species are endemic, nearly all genera are found in northern Borneo. Of 25 indigenous non-volant mammal species 11 (44%) are endemic and the rest are shared with Borneo. Thus, Palawan is part of the Sunda zoogeographic province, not the Philippine faunal province (Heaney, 1986). A considerable number of birds are endemic to Palawan, and various reptiles, including crocodile Crocodylus palustris and possibly C. mindorensis, hawksbill turtle Eretmochelys imbricata (E) and green turtle Chelonia mydas (E), and monitor Varanus sp. are found (HTS, 1983).

## CULTURAL HERITAGE No information

LOCAL HUMAN POPULATION The indigenous peoples include the Palawanos, Bataks and Tagbanua. Many still follow their traditional nomadic culture, but efforts have been made to settle them in permanent villages under the government "Panamin Project". The 1989 population in the biosphere reserve was 200 in the core areas, 20,000 in the buffer zones and 349,782 in the transition areas. Of the total land area of 1,489,626ha, some 740,000ha are suitable for agriculture or agroforestry. Agriculture is the largest sector of the island's economy, employing some 80% of the workforce in 1975. Upland agriculture is restricted to kaingin (slash and burn). Settled agriculture is pursued on 95,200ha, or only 8% of the mainland area, the major crops being rice, coconut and maize. Land cleared for shifting agriculture covers 264,000ha, or 23% of the mainland. Numerous minor forest products are exploited on a subsistence basis including almaciga resin, rattan, bamboo, tannin, honey, fauna such as parrots, scaly anteater, wild boar etc. Although collection has been on a sustainable basis there are indications of over-exploitation. There is also traditional and subsistence exploitation of mangroves, and again there are indications that this is increasingly unsustainable, with the loss of 30% of mangrove cover between 1968 and 1980. More recent data are not available.

VISITORS AND VISITOR FACILITIES Tourism is a relatively small industry on Palawan compared with other parts of the Philippines.

SCIENTIFIC RESEARCH AND FACILITIES The Palawan Expedition (Jan/Feb 1980), run by Traditional Explorations and the Sydney Speleological Society of Australia, set out to observe and record a general impression of the environmental status of the island and suggest some useful directions for further more detailed work. Subsequent work has included the Integrated Environmental Program (HTS, 1983), and the Strategic Environmental Plan (PIADPO, n.d.). The biosphere reserve nomination provides a summary of previous, on-going and planned research. A number of research facilities and institutions are located at Puerto Princesa.

CONSERVATION VALUE The biosphere reserve nomination states that the primary purposes of the reserves are the conservation of natural or minimally disturbed ecosystems; making provision for the legal or administrative protection and management of the site; research on ecosystem management and conservation and long-term environmental monitoring. Habitats of particular conservation interest include mossy, deciduous and montane rain forest, mangrove, open grassland, seagrass bed, coral reefs and small islands.

CONSERVATION MANAGEMENT A total of 11 legal enactments, establishing a number of protected areas within the biosphere reserve, is listed in the nomination form (Anon., 1990). The biosphere reserve zonation is based on that established under the Ecologically Critical Areas Network (ECAN), itself a product of the Strategic Environmental Plan (PIADPO, n.d.) The findings of the Strategic Environment Plan concluded that a network of protected areas would not prevent environmental deterioration because it would not gain the support of local communities. The ECAN was envisaged as an extensive zonation system, covering the entire island, which is intended to ensure protection of watersheds, biological diversity, rare and endangered species, tribal people and their culture, the maintenance of sustainable yields and provision for research and tourism. Four zones were planned, namely core zone; buffer zone, comprising restricted use, controlled use and traditional use sub-zones; multiple use zone; and a marine area, extending to the 100 fathom isobath.

It is envisaged, under HB 19576, that the Palawan Council for Sustainable Development will be organised to exercise the governance, implementation and policy direction of the Strategic Environmental Plan. The council shall be under the Office of the President of the Republic and shall comprise members of the House of Representatives for Palawan, Deputy Director-General of the National Economic Development Authority, Undersecretary of the Department of Environment and Natural Resources, Undersecretary for Special Concerns of the Department of Agriculture, Governor of Palawan, Mayor of Puerto Princesa City, President of the Mayor's League of Palawan, the Executive Director of the Council Staff and representatives from the public and private sectors. HB 19576 also provides for the conversion of the Palawan Integrated Area Development Project Office (PIADPO) to the Palawan Council for Sustainable Development Staff, charged with coordinating policy, implementing programmes, and organising other functions as required by the Council.

The MAB Committee, located at Quezon City under the Department of Environment and Natural Resources, functions as a coordinating agency, and works with the Parks and Wildlife Bureau, Forest Management Bureau, Ecosystems Research and Development Bureau and Environmental Management Bureau as appropriate. There are three major international projects underway in Palawan comprising the Japan International Cooperation Agency's RP-Japan Crocodile Farming Institute, the European Economic Community's Integrated Environmental Programme and the Asian Development Banks Palawan Integrated Area Development Project.

MANAGEMENT CONSTRAINTS Logging, mining and the spread of shifting cultivation, due to the influx of jobless migrants, pose serious environmental threats. Data for 1985 indicate that the gross area under Timber Licence Agreements was 288,620ha, of which some 200,263ha were considered productive. Approximately 28,802ha was estimated to have been logged. More recent data suggest an annual rate of loss of some 19,000ha (Anon., 1988). Coral reefs have been degraded as a result of sedimentation, a consequence of forest clearance, fishing with dynamite and use of sodium cyanide. Seagrass beds have also been degraded due to siltation and trawling and the loss of mangroves has serious implication for the sustainability of local fisheries (Anon., 1990; Pido, 1988).

STAFF A total of 23 research staff work in the biosphere reserve, under the auspices of different national and international agencies, there being no separate administration for research within the biosphere reserve.

BUDGET No information

LOCAL ADDRESSES Palawan Integrated Areas Development Project Office, Irawan, Puerto Princesa

Man and the Biosphere (MAB) Programme, 4th Floor Asiatruster Bank Building, 1424 Quezon Avenue, Quezon City

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## SWEDEN

NAME Lake Torne Area (Torneträsk) (includes Abisko and Vadvetjakka national parks)

IUCN MANAGEMENT CATEGORY I (Strict Nature Reserve)  
II (National Park)  
IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 2.06.05 (Subarctic Birchwoods)

GEOGRAPHICAL LOCATION Situated in the northernmost part of Sweden, the reserve is centred around Lake Torne. The northern boundary follows the border with Norway, while the southern boundary follows the south bank of Lake Torne. Extensions includes Vadvetjakka, Abisko and Stordalens. 68°25'N, 19°00'E

DATE AND HISTORY OF ESTABLISHMENT The first of the protected areas was established in 1909. All sites are covered under the national conservation legislation, the Nature Conservancy Act. The main sites include Storlands Nature Reserve (established 1980), Abisko Scientific Research Station Nature Reserve (established 1982), Abisko National Park (established 1909) and Vadvetjakka National Park (established 1920). The entire Lake Torne area was accepted as a biosphere reserve in October 1986.

AREA The biosphere reserve covers 96,500ha and includes: Abisko National Park (6,877ha), Vadvetjakka National Park (2,582ha), Stordalens Nature Reserve (1,000ha), Abisko Scientific Research Station Nature Reserve (500ha) and Lake Torne (25,000ha) (Swedish Environmental Board, 1986).

LAND TENURE State ownership

ALTITUDE 340-1,610m

PHYSICAL FEATURES The area consists of mountainous landscapes to the west, dominated by rock outcrops, and to the north where there are high mountain massifs up to 1,600m. Lake Torne lies along a north-west axis and was formed as a result of glaciation and is extremely oligotrophic. The area includes alpine and subalpine zones, areas of barren rocks as well as alpine valleys (as typified by Abiskohokk Valley itself), mountain slopes, lakes (most notably Torneträsk) and watercourses. Karst phenomena, with caves, occur in the limestone bedrock north of Lake Torne (Swedish Environmental Board, 1986; Naturvardsverket, 1989).

CLIMATE Mean annual rainfall ranges from 1500mm in Vadvetjakka National Park to only 300mm per year in Abisko National Park (a very low figure for Sweden). At Abisko there is low annual precipitation due to the associated rain shadow.

VEGETATION Extensive areas are covered with different types of birch forest dominated by *Betula* spp. There are alpine and subalpine heaths (represented by heather *Calluna* sp. and bilberry *Vaccinium* spp.) and meadows. Due to the calcareous soil, the flora is locally very rich. There are also wetlands north of the lake which vary from rich fens to poor swamps. The flora of the Abisko area is of particular interest, with nationally threatened plants such as *Platanthera oligantha*, *Epipogium aphyllum* and *Milandrium apetalum* present (Swedish Environmental Board, 1986; Naturvardsverket, 1989). In Vadvetjakka national park the rich flora influenced by prevailing humid winds and calcareous bedrocks.

Extensive areas are covered by birch and willow thickets and mire vegetation. Prominent species are Betula nana, Phyllodoce caerulea, Hierochloa alpina and Cassiope hypnoides.

**FAUNA** Common animal species include moose Alces alces, wood hare Lepus timidus, ermine Mustela erminea, pine marten Martes martes and several species of small rodents such as lemming Lemmus lemmus. Uncommon mammal species are brown bear Ursus arctos, lynx Lynx lynx, wolverine Gulo gulo, Arctic fox Alopex lagopus and otter Lutra lutra (V). Domesticated reindeer Rangifer tarandus are found throughout the whole area. Typical bird species are dotterel Charadrius morinellus, golden plover Pluvialis apricaria, long-tailed skua Stercorarius longicaudus, rough-legged buzzard Buteo lagopus, merlin Falco columbarius, red-necked phalarope Phalaropus lobatus, Temminck's stint Calidris temminckii, willow grouse Lagopus lagopus and ptarmigan Lagopus mutus. Threatened birds include gyrfalcon Falco rusticolus, golden eagle Aquila chrysaetos, shore lark Eremophila alpestris and Arctic warbler Phylloscopus borealis (Swedish Environmental Board, 1986; Naturvårdsverket, 1989).

**CULTURAL HERITAGE** The area has been used by the nomadic Lapp people and their domestic reindeer for several centuries. Traditional activities also include hunting and fishing.

**LOCAL HUMAN POPULATION** Traditional Lapp farming has been modified with the use of off-road vehicles. The Lapps lead less of a nomadic life than in the past. Revenue generated by visitors to the protected areas and from hunting and fishing has contributed to the local economy.

**VISITORS AND VISITOR FACILITIES** The number of visitors to a particular area depends on accessibility. The area north of Lake Torne is largely without roads and, as off-road driving is forbidden, few tourists visit the area. To the south of the lake though, there is a railway and roads that provide good access. Abisko National Park has about 30,000 visitors a year (Swedish Environmental Board, 1986). Facilities here are varied and attract tourists throughout the year. Part of the Abisko area is intensively used for recreation including skiing at Mount Njulla with cable cars and marked trails. During the summer the area is widely used by hikers. Other facilities include a tourist station (where overnight accommodation is available), overnight cabins and an information centre (Swedish Environmental Board, 1986; Naturvårdsverket, 1989).

**SCIENTIFIC RESEARCH AND FACILITIES** The Abisko Scientific Research Station was established in 1903. Ongoing studies concern the effects of tourism on the environment. Within the Abisko area, monitoring of terrestrial and limnological ecosystems form part of the National Monitoring Programme in Sweden (Swedish Environmental Board, 1986). Ongoing ecological work includes plant, ecological and ornithological studies (Swedish Environmental Board, 1986). Abisko Scientific Research Station is situated close to the park. Study reports are available on fauna and flora (1964, 1967) and on geomorphology (Swedish Environmental Board, 1986).

**CONSERVATION VALUE** Much of the area was established to preserve a subarctic/subalpine area in its natural state and to promote current and future research on its typical and undamaged northern fauna and flora.

**CONSERVATION MANAGEMENT** The long history of scientific research and preservation of the areas in their natural state are the main reasons for creating a biosphere reserve. Regulations applied in the two national parks and two nature reserves



are stricter than elsewhere. These four areas, totalling 110,500ha, are regarded as core areas by the Swedish Environmental Protection Board. The whole area south of Abisko National Park is part of a "roadless mountain area" (Swedish Environmental Board, 1986).

The responsible authority for the biosphere reserve is the Mountain Unit of Statens Naturvårdsverk SNV (National Environmental Protection Board) and the county administration. The interests of the native populations (Lapps) are looked after by the management council (which is the advisory body to the Mountain Unit), by the representatives from the four mountain municipalities, by the county administration and by the board. The delta of Abiskoja River within Abisko National Park is protected as a bird sanctuary and access is prohibited from 1 May to 31 July. Reindeer husbandry is considered fully compatible with the purposes of the biosphere reserve (Swedish Environmental Board, 1986; Naturvårdsverket, 1989). The important areas, such as nature reserves, are protected by limiting access. Resource exploitation, such as forestry, is not allowed without the permission of the Swedish parliament.

MANAGEMENT CONSTRAINTS There are few recognised management problems in the area. It is not yet known how much of a threat off-road vehicles will prove to be (Swedish Environmental Board, 1986).

STAFF Fourteen, including wardens and rangers (Swedish Environmental Board, 1986). The number of permanent personnel at the Abisko Scientific Research Station is ten. At Vadvetjakka and Abisko national parks there are administrative and wardening staff corresponding to one full-time employee.

BUDGET Vadvetjakka and Abisko national park budgets were about US\$10,000 each in 1978/1979 (Swedish Environmental Board, 1986).

LOCAL ADDRESSES Lake Torne Biosphere Reserve, Statens Naturvårdsverk SNV, Åsgården 20, S-960 40 Jokkmokk  
Vadvetjakka and Abisko national parks are administered by the Forest Service, Gällivare revir, S-972 00 Gällivare

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## UNITED STATES OF AMERICA

NAME Carolinian-South Atlantic Biosphere Reserve

IUCN MANAGEMENT CATEGORY IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 1.06.05 (Austro-riparian)

GEOGRAPHICAL LOCATION The biosphere reserve includes many sites along the coasts of three states, and has been divided into three units: Outer Banks subregion (North Carolina), Santee Delta-Cape Romain subregion (South Carolina) and Sea Islands subregion (Georgia). Approximately 30°10'-30°50'N, 76°00'-81°35'W

DATE AND HISTORY OF ESTABLISHMENT Declared a biosphere reserve in 1986, with Hobcaw Barony added in 1987. See each subregion for establishment of individual protected areas.

AREA 157,105ha. Outer Banks subregion: 55,789ha with a core area of 11,500ha. Santee Delta-Cape Romain subregion: 47,995ha with a core area of 9,324ha. Sea Islands subregion: 53,321ha with a core area of 36,740ha.

LAND TENURE Much of the biosphere reserve is federally or state owned with small areas owned by the Nature Conservancy, Bureau of Outdoor Recreation and private land owners (see each subregion for details).

ALTITUDE 0-20m

PHYSICAL FEATURES Two distinct physical regions and a transition zone have been identified within the reserve. In the north the area from Cape Fear to Cape Hatteras is dominated by long, narrow barrier islands with few inlets, cusped capes, and small tidal amplitudes. At the southern end the Georgia Embayment has large sea islands, numerous inlets and large tidal amplitudes. Between this is a transitional area, located primarily along the coast of South Carolina. These regions correspond broadly to the three subregions of the biosphere reserve (see individual subregions for further details).

CLIMATE Mean annual temperature ranges from 17°C-20.4°C and mean annual precipitation from 1230mm-1320mm.

OTHER INFORMATION See individual subregions

### Carolinian-South Atlantic Biosphere Reserve: Outer Banks Subregion

IUCN MANAGEMENT CATEGORY II (National Park)  
IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 1.06.05 (Austro-riparian)

GEOGRAPHICAL LOCATION The area comprises two sections: a) Offshore islands in Carteret County, North Carolina, contained in Cape Lookout National Seashore. The nearest town is Beaufort (3km from the closest point) while the western end is 4km from Morehead City. Centred 34°45'N, 76°20'W.

b) A marine area on the continental shelf which includes two sites: the inner shelf site (Ten Fathom Ledge) comprising a rectangle of ocean between 34°13'-34°26'N, 76°29'-76°37'W, and the outer shelf site (Big Rock, 58km offshore) a

rectangle between 34°07'-34°12'N, 76°10'-76°15W.

**DATE AND HISTORY OF ESTABLISHMENT** The inshore section (a) was established on 10 March 1966 as a national seashore by Public Law 89-366, 89th Congress, Statute 251. The offshore areas (b) have been proposed as a marine sanctuary. Accepted as a biosphere reserve in 1986.

**AREA** The unit covers a total area of 55,789ha with a core area of 11,500ha (Cape Lookout National Seashore) and a buffer zone of 44,289ha (Big Rock area and Ten Fathom Ledge). Within the buffer zone, 3.5ha at Ten Fathom Ledge and 0.9ha at Big Rock are above sea level.

**LAND TENURE** Federally owned, the offshore section being entirely within federal waters.

**ALTITUDE** Land section 0-10m with depths of up to 120m offshore.

**PHYSICAL FEATURES** (a) Cape Lookout National Seashore comprises an 88km narrow strip of sandy barrier islands, breached by two permanent inlets, Barden and Drum Inlets. Barden and Beaufort Inlet, at the western extremity, are artificially maintained by dredging. Numerous temporary breaches develop from time to time and the whole island system is dynamic, being constantly shifted by wind and waves. Shackleford Banks, the most stabilised section at the western end, are aligned west-north-west/east-south-east across the mouth of the North River, while the eastern portion (Core Banks and Portsmouth Island) are aligned south-west to north-east with the recurved ridges of Cape Lookout at their south-western extremity. There are three types of coastal barrier island: linear arcuate dune ridge barrier up to 10m high (Shackleford Banks); cusped cape (Cape Lookout) and low elevation linear washover/inlet (Core Banks and Portsmouth Island). Shackleton Banks is the only area above the 100-year floodplain as it faces the prevailing winds so that sand tends to accumulate to increase their height. These barrier islands are all backed by lagoons: Back, Core and Pamlico Sounds. Soils are poorly developed and are of two main types: sand and marsh soils.

(b) Ten Fathom Ledge is a nearshore high-relief area with a relief of 1-5m. The Big Rock area further offshore is located on the continental shelf break with depths between 60m and 120m. In the deepest areas there is upwelling of cold water.

**CLIMATE** Average annual temperature is 17°C and mean annual precipitation 1321mm (inshore section). Two types of severe storms affect this area: hurricanes (of tropical origin) and north-easters (extratropical storms), the latter being more frequent.

**VEGETATION** a) Cape Lookout: the different communities occur in zones, dependent primarily on height above the high tide level. They include (dominant species in brackets): maritime forest (live oak Quercus virginiana, red cedar Juniperus virginiana, holly Ilex opaca); coastal shrubland (bayberry Myrica sp., yaupon holly Ilex vomitoria, groundsel bush Baccharis halimifolia, scrub oak Q. ilicifolia); coastal grasslands with dune strand species and barrier flat vegetation (sea oats Uniola paniculata and salt meadow cordgrass Spartina patens); coastal marshes (salt marsh smooth cordgrass S. alterniflora, with salt meadow cordgrass and needlerush Juncus roemerianus in the upper tidal zone). There are also subtidal grass beds (eel grass Zostera maritima, widgeon grass Ruppia maritima). Some non-native slash pines Pinus elliottii were planted near the lighthouse before the area was protected. A species list is available.

b) Ten Fathom Ridge/Big Rock area: At least 40 algal species, dominated by brown

algae, have been recorded; occurrence and abundance is seasonal.

**FAUNA** a) Cape Lookout National Seashore: the diverse, representative fauna includes a variety of waders and grassland birds of both resident and migratory species. Large numbers of little tern Sterna albifrons, common tern S. hirundo, gull-billed tern Gelochelidon nilotica and black skimmer Rynchops niger (the first three being species of special concern in North Carolina) nest in colonies along the beach or berm. The federally endangered eastern brown pelican Pelecanus occidentalis is resident (up to 500 individuals) this being its most northerly nesting site. Atlantic loggerhead sea turtle Caretta caretta (V) nests on the beaches, there being 72 nests recorded in 1979. Another federally listed species the Atlantic leatherback sea turtle was recorded nesting once in 1966. Tree frogs, toads and snakes are present; shrews, raccoons Procyon lotor and rabbits are found in the shrub thickets. Feral livestock are present on Shackleford Banks.

b) At Ten Fathom Ledge nearly 100 species of fish have been identified, including black sea bass, gog, scamp, various porgies and hog-fishes, purple reef fish and yellowtail reef fish. It has six separate hard ground ledges of varying relief with subtropical algal and coral communities. Live-bottom areas in transitional depths of 30-40m show an increased dominance of subtropical biota as they are less influenced by seasonal changes in water temperature than communities nearer the shore. Fish diversity peaks at depths of 40-75m which typically have stable temperatures. The Big Rock area has fewer fish species but has large populations of several economically important species including billfish.

**CULTURAL HERITAGE** The Outer Banks has had a long maritime history. Cape Lookout lighthouse, built in 1859 on the site of an earlier tower dating from 1812, marks the dangerous shoals off this point. With its 25 acre complex is a keeper's quarters, fuel store and summer kitchen. A settlement known as Diamond City was once established on Shackleford Banks but abandoned after hurricanes in the late 19th century and now very little of it still remains. Portsmouth Village, at the eastern end of Portsmouth island, was once a transshipment point and 25 structures typical of coastal Carolinian architecture of the 1820-1930 period still exist. A 250 acre area here and the Cape Lookout lighthouse complex are listed in the National Register of Historic Places.

**LOCAL HUMAN POPULATION** There is a ranger station near Cape Lookout lighthouse and some dwellings at Portsmouth Village.

**VISITORS AND VISITOR FACILITIES** Cape Lookout National Seashore has large numbers of visitors (about 55,000 in 1981) most of whom come from June to November. Access is easy and there are four ferry routes from various points on the mainland operated by five private companies which carry over 1,000 vehicles per year. People also visit in their own boats. On the islands there is a tractor-drawn vehicle which transports visitors from one ferry terminal to Cape Lookout Point. Otherwise, people can drive along the islands in their own vehicles and some do this in the pursuit of waterfowl. There are cabins for rent which are usually filled to capacity at weekends in October and November, the best fishing season. Over 12,000 camper nights in cabins and 10,000 nights in tents were recorded in 1981. Almost all cabin parties bring a vehicle with them. On Core Banks there are also a number of summer cottages on lease from the NPS. In the event of storm conditions the islands will be closed to visitors who will be evacuated if necessary. The reefs of the Ten Fathom Ledge and Big Rock area are visited by many scuba-divers and recreational fishermen and rod and line fishing by tourists also occurs over some of the hard grounds.

SCIENTIFIC RESEARCH AND FACILITIES The Outer Banks have been the subject of a considerable amount of scientific research. Studies include the geology, ecological effects of over-wash, dune stabilization, ecology of dune strand plants, stabilisation of dredge spoil and rates of beach recession. Long-term monitoring at Cape Lookout includes turtle surveys, changes in beach erosion and accretion, vegetation transects, physiography, fire studies, visitor use and bird censusing. There is long term monitoring on Ten Fathom Ledge of the fish species present. Scientific facilities in the unit include a field station, experimental plots and a climate station. Accommodation is available for scientists in the National Park Service headquarters and a nearby marine laboratory.

CONSERVATION VALUE This area includes a relatively undisturbed ecosystem of barrier islands typical of this coastline. Dynamic coastal processes are continuing naturally and an area of accumulating sand dunes is included. Vegetation includes marsh communities, strandline vegetation, successional sand dune communities, maritime forest. There are also cultural sites reflecting 19th century uses of the area. Two areas of the seabed offshore which are included have a particularly diverse fish fauna and are used by turtles.

CONSERVATION MANAGEMENT Cape Lookout is managed as the core area; Ten Fathom Ledge/Big Rock is an offshore cooperative use area. There is a management plan for Cape Lookout National Seashore which addresses management zoning (natural, historic, development, special use), management of natural and cultural resources, interpretation, visitor use and overall development. Hunting and fishing are allowed within the laws of the state of North Carolina and the United States. There is a ranger station a mile south of the lighthouse. The US Army Corps of Engineers contributes to controlling shore erosion and keeping inlets dredged. Certain islands and offshore areas north of Barden Inlet have been reserved for dumping spoil from channel dredging. Ferry operators and camp or cabin renters operate under permit which enables use to be controlled. Twelve special use permits exist for occupancy of structures within Portsmouth Village to help protect the historic structures here. Feral ungulates still graze grasslands on Shackleford Banks but all livestock was removed from the other islands in the 1960s. Development of extra administration facilities will occur on Harkers Island, which is just outside the National Seashore but connected to the mainland by a bridge and is the terminus for one of the ferry routes.

MANAGEMENT CONSTRAINTS The system of islands, marshes and lagoons has not been modified extensively by human activities and therefore continues to develop according to natural physical conditions on this coast. The region supports a substantial marine ecosystem on both sides of the barrier islands which is relatively undisturbed except for the many years of commercial fishing. Before the area was taken over by the NPS there were some 340 shacks and 2,500 abandoned, broken-down vehicles littering the islands, but now all but 600 vehicles have been removed and the seashore cleaned up. Campgrounds or other facilities are kept to the minimum needed for park use. The Ten Fathom Ledge area is subjected to recreational use by man, including scuba diving and fishing but this has little impact although anchoring may do some damage if it is not controlled. Commercial trawling occurs over some low-relief hard grounds and there is potential danger of reef destruction through the use of roller trawls, especially of coral colonies located on flatter bottoms away from the main reef pinnacles. The Bureau of Mines of the US Department of the Interior has indicated that the Ten Fathom Ledge/Big Rock area may have exploitable mineral resources and the possibility of oil and gas exploration are a present concern as this whole coastline is now open to leasing for exploration.

STAFF There are 18 permanent staff and 13 temporary staff.

BUDGET No information

LOCAL ADDRESSES Cape Lookout National Seashore: Superintendent, Cape Lookout National Seashore, P O Box 690, Beaufort, North Carolina 28516  
Ten Fathom Ledge and Big Rock Area, NOAA Marine Sanctuaries Program, 3300 Whitehaven Street NW, Washington, DC 20036

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Searles, R.B. and Schneider, C.W. (1980). Biogeographical affinities of the shallow and deep water benthic algae of North Carolina: Bull. Mar. Sci. Gulf and Caribb. 30: 732-736.

**Carolinian-South Atlantic Biosphere Reserve: Santee Delta-Cape Romain Subregion**

IUCN MANAGEMENT CATEGORY

- I (Strict Nature Reserve)
- V (Protected Landscape)
- VI (Resource Reserve)
- IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 1.06.05 (Austro-riparian)

GEOGRAPHICAL LOCATION The entire reserve is located in two counties, Charleston and Georgetown, in South Carolina. It is approximately 32km north-east of the city of Charleston and 16km south-east of the city of Georgetown. The reserve is bordered on the east by the Atlantic Ocean, on the west by the Intracoastal Waterway, to the north by the northern boundary of Hobcaw Barony and to the south by Capers Inlet. Across the Intracoastal Waterway to the west is Frances Marion National Forest. 33°07'N, 79°20'W

DATE AND HISTORY OF ESTABLISHMENT a) Cape Romain Refuge: established, excluding

Bulls Island, in 1932. Closed to migratory bird hunting by Presidential Proclamation 2000. Bulls Island was added to the refuge in 1936. Wilderness Area established and protected by Public Law 93-632 dated 1.3.75. b) Yawkey Wildlife Centre: became state land under Carolina Heritage Trust Agreement and Easement Act No. 600 in 1976. c) Santee Coastal Reserve: ownership went to the state of South Carolina from The Nature Conservancy on 20 September 1974. d) Washo Reserve: established in 1974, property leased to the state by The Nature Conservancy with conservation restrictions. e) Capers Island Heritage Preserve: became state owned in 1975 with Bureau of Outdoor Recreation funds. f) Hobcaw Barony: privately owned by the Belle W. Baruch Foundation and is protected under a legal trust for conservation, research and educational purposes. The Belle W Baruch Foundation was established in 1964. In 1968 the Belle W Baruch Institute for Marine Biology and Coastal Research, University of South Carolina and the Belle W Baruch Forest Science Institute, Clemson University, were founded. Areas (a) - (e) accepted in 1986 as a biosphere reserve; on 25 March 1987 the biosphere reserve was extended by increasing the area of the Cape Romain Refuge and including Hobcaw Barony.

**AREA** The total area is 47,995ha (increased in 1987 from 32,474ha) including a core area of 9,324ha. Different units consist of: Washoo Reserve 421ha; Yawkey Wildlife Centre: North Island 1,821ha and South Cat Islands 6,659ha; Cape Romain Refuge 22,294ha; Capers Island 809ha; Santee Delta Reserve 8,906ha and Hobcaw Barony 7,085ha.

**LAND TENURE** The state owns 22,294ha in the form of US federal lands under the Fish and Wildlife Service. The state of South Carolina owns 16,374ha including 1,821ha of the core zone. The Nature Conservancy owns 421ha in the core zone. The remaining 7,085ha of the core zone are owned by the Belle W. Baruch Foundation.

**ALTITUDE** 0-12.8m

**PHYSICAL FEATURES** This subregion is a continuous stretch of coastline although it comprises a number of different reserves. It contains both representative features of the lower coastal plain in this region and some unique formations. It includes nine contiguous barrier islands, a true embayment (Bull's Bay), a cusped foreland (Cape Island) and seven major estuaries (including North Inlet, Winyah Bay, and North and South Santee rivers). The Santee River delta is one of the most active river deltas on the Atlantic coast of the USA. There are extensive salt marshes, with numerous inlets and small islands. Some impounded areas of marsh formerly used for rice cultivation are also present. Pleistocene sediments compose the core of the barrier islands formed in response to sea level rise. Tides are in the mesotidal range.

**CLIMATE** The mean annual temperature is 19°C and the mean annual precipitation is 1320mm.

**VEGETATION** The major communities and commonest species in each are: salt marsh - smooth cordgrass Spartina alterniflora and saltmeadow cordgrass S. patens. Dune community - sea oats Uniola paniculata, panic grass Panicum sp., sandspur Cenchrus tribuloides, beach pennywort Hydrocotyle bonariensis, brown sedge, prickly pear Opuntia humifusa, cabbage palmetto Sabal palmetto, wax myrtle Myrica cerifera. Transition and shrub communities - wax myrtle, yaupon holly Ilex vomitoria, red bay Persea borbonia, eastern red cedar Juniperus virginiana, live oak Quercus virginiana, catbrier Smilax auriculata, pepper vine Ampelopsis arborea, trumpet vine, Virginia creeper Parthenocissus quinquefolia, sea myrtle Baccharis halimifolia, sea ox-eye Borrchia frutescens, black needlerush Juncus

sp. Maritime forest - live oak, laurel oak Quercus laurifolia, cabbage palmetto, magnolia Magnolia sp., loblolly pine Pinus taeda, southern red cedar, yaupon holly, red bay, and American holly Ilex opaca. Other communities also include bald cypress Taxodium distichum-tupelo Nyssa aquatica, gum swamp Liquidambar styraciflua, and pocosins. Threatened plants include Sarracenia rubra and Dionea muscipula. A species list is available.

Hobcaw Barony comprises the following habitats: a) pine flatwoods of which 43% (853ha) is occupied by stands over 100 years old and 75% (1,192ha) by stands over 60 years old; b) virgin longleaf stand over 150 years old (29ha); c) loblolly pine has stands in every 10-year age class up to 100 years; d) plantations less than 5 years old (20ha); e) naturally regenerated stands less than 20 years old (174ha); f) natural areas, encompassing old growth cypress swamp and border area of old growth loblolly and longleaf pine.

FAUNA There are large numbers of waders and colonial waterbirds with ten species of migratory or resident endangered or threatened species, including osprey. There is a rookery in the Washoo Reserve. Mammals include bottlenose dolphin Tursiops truncatus, mink Mustela vison, otter Lutra canadensis and raccoon Procyon lotor and among the reptiles found are American alligator Alligator mississippiensis and loggerhead sea turtle Caretta caretta (V). A species list is available.

CULTURAL HERITAGE Apart from some cultivation of rice in the 1800s, there has been very little development. North Island lighthouse was listed as a national historic landmark on 30 December 1974. There is an old triangulation station on the south-western tip of Capers Island which is still functional and should be preserved as it represents the best way of obtaining the planimetric control necessary for comparison of shoreline changes in the area. Some remains of old dwellings dating from about 1800 also exist on this island. A shell mound has been found nearby, also containing pieces of pottery and may be of Indian origin. On Hobcaw Barony is located the vacation home of the late Mr Bernard W Baruch. The Barony is a collection of early colonial rice plantations. Remnants of early plantation villages and former slave quarters, the remains of a colonial fort and a cemetery still exist.

LOCAL HUMAN POPULATION There are 14 family dwellings on the entire reserve. All roads are dirt tracks and buildings have been kept to a minimum.

VISITORS AND VISITOR FACILITIES Cape Romain Refuge: there is a new visitor contact station with various exhibits depicting refuge wildlife, informational pamphlets and species lists. Yawkey Wildlife Centre: weekly educational field trips for 14 persons are available with graduate student field trips or inspection of prototype management activities as requested. Cape Romain Refuge: nature trails for hiking. Santee Coastal Reserve: nature trails and boardwalks. Hobcaw Barony: Bellefield Nature Centre contains exhibits and provides instructional programmes on the history of the Hobcaw Barony, coastal ecosystems and the site's activities. The Belle W. Baruch Foundation sponsors short courses, coastal ecology classes, teacher workshops, field studies for interested groups and guided tours of the site.

SCIENTIFIC RESEARCH AND FACILITIES Major research includes: waterfowl ecology, impounded and unimpounded marsh ecology, forest wildlife and endangered species ecology and coastal wilderness research. Experimental impoundments with individual water control structures are available with much base line information already collected. The area is important for the study of coastal processes since



the diversion of the Santee River in 1940 and the scheduled redirection in the near future. All local populations are monitored to some degree and there is especially detailed monitoring of populations of endangered and threatened species including loggerhead turtles, bald eagles Haliaeetus leucocephalus, osprey Pandion haliaetus, red-cockaded woodpecker Picoides borealis and some game species. The scientific facilities available in the unit include a field station, experimental plots and four small dormitories on Yawkey and one on Cape Romain. Hobcaw Barony is a major centre for long-term ecological research on estuarine ecosystems, conducted through the Belle W. Baruch Institute for Marine Biology and Coastal Research (University of South Carolina) and research on forest ecosystems of the outer coastal plain, conducted through the Belle W. Baruch Forest Science Institute (Clemson University). Access to Yawkey Centre is restricted by ferry operations and many of the islands are approached by boat access only.

**CONSERVATION VALUE** The reserve contains a complex of barrier islands, marshes and estuaries, the estuary of the Santee river being the most active in this part of the east coast. A great variety of relatively undisturbed habitats are present, including marshes, pine and broadleaf woodlands and a range of coastal successional communities. Large numbers of waders and waterfowl use the area.

**CONSERVATION MANAGEMENT** Yawkey Wildlife Centre's management plan is structured around the stipulations in the will of the late Mr Tom Yawkey. It allows for research, management and education on the majority of the property excepting North Island. Santee Coastal Reserve (including Washoo Reserve), Cape Romain and Caper Island all have management plans addressing the various management practices and the species involved.

Core areas: on North Island 1,821ha was established as wilderness area under the Yawkey will and no management activities are allowed. All of Washoo Reserve (421ha) has use restrictions under the management of The Nature Conservancy to protect the sensitive rookery area. All of Hobcaw Barony (7,082ha) is strictly protected for research, education and conservation of natural ecosystems according to the will of Miss Baruch. The marshlands and forests of Hobcaw Barony are managed for scientific and educational purposes by the University of South Carolina (marsh-marine) and Clemson University (forest-marine) under a long-term contract.

Buffer zones (total of 38,671ha) are managed for wildlife populations including waterfowl, white-tailed deer Odocoileus virginianus, wild turkey Meleagris gallopavo and endangered species. Water levels are controlled to benefit wildlife in parts of the reserve such as South Island. On this island a flock of captive Canada geese is maintained by planting cereals so that they will act as a decoy and attract migratory flocks to the area.

**MANAGEMENT CONSTRAINTS** Apart from rice cultivation in the 1800s, which took place on marshland throughout the reserve, the area has experienced very little development. Some areas of mixed forest within Yawkey Centre and Santee Coastal Reserve have been replaced with pine forest. There is tourism, commercial and recreational fishing, crabbing and boating in areas of the reserve.

**STAFF** Total of 120; this includes, at the largest research facilities which are concentrated on Hobcaw Barony, five at the Baruch Foundation; the University of South Carolina has a permanent resident staff at the field station of 20 and averages 8 temporary staff; in addition, the Institute staff in Columbia numbers approximately 50. Clemson University has a residential coastal staff of 25.

BUDGET No information

LOCAL ADDRESSES

S.C. Wildlife and Marine Reserve, P O Box 12559, Charleston, SC 29412  
Washoo Reserve, The Nature Conservancy, P O Box 5475, 724B Meadow Street,  
Columbia SC 29250  
Cape Romain Refuge, 390 Bulls Island Road, Awendow SC 29499  
Hobcaw Barony: Executive Director, Belle W Baruch Foundation, Bellefield  
Plantations, P O Box 578, Georgetown, SC 29440  
Baruch Institute for Marine Biology & Coastal Research, University of South  
Carolina, P O Box 1630, Georgetown SC 29440  
Assistant Director, Belle W. Baruch Forest Science Institute of Clemson  
University, P O Box 596, Georgetown, SC 29440

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## **Carolinian-South Atlantic Biosphere Reserve: Sea Islands Subregion**

### **IUCN MANAGEMENT CATEGORY**

- I (Strict Nature Reserve)
- II (National Park)
- VIII (Multiple Use Management Area)
- IX (Biosphere Reserve)

**BIOGEOGRAPHICAL PROVINCE** 1.06.05 (Australoriparian)

**GEOGRAPHICAL LOCATION** The Sea Islands Unit is composed of ten sites off the coast of the state of Georgia. These are: Blackbeard Island National Wildlife Refuge, Blackbeard Island Wilderness, R.J. Reynolds State Wildlife Management Area (on Sapelo Island), Sapelo Island National Estuarine Sanctuary, Wolf Island Wilderness, Lewis Island Natural Area, Altamaha State Waterfowl Management Area, Little St Simon's Island, Cumberland Island National Seashore, and Gray's Reef National Marine Sanctuary. Most of these sites are contiguous but Cumberland Island is about 30km south of the main bloc and Gray's Reef about 25km offshore. 30°50'-41°23'N, 80°51'-82°17'W

**DATE AND HISTORY OF ESTABLISHMENT** Level of protection for all sites is high. Cumberland Island National Seashore: establishment of seashore (P.L. 92-536) and wilderness designation (P.L. 97-250). Blackbeard Island National Wildlife Refuge: designation of wilderness area (P.L. 93-632). Sapelo Island National Estuarine Sanctuary: establishment of the National Estuarine Sanctuary Program (P.L. 92-583). Lewis Island Natural Area: acquisition under Georgia Heritage Trust Act (GA Laws, 1974, p. 962) and designation as a Registered National Natural Landmark. Wolf Island National Wildlife Refuge: designation of wilderness area (P.L. 93-632). Little St Simon's: protected under the coastal barrier resources act. Gray's Reef National Marine Sanctuary: designated in January 1972 under the National Marine Sanctuary Program (P.L. 92-532). These areas together were accepted in 1986 as a biosphere reserve

**AREA** The unit covers an area of 53,321ha with a core area of 36,740ha. The core area comprises: Cumberland Island 6,113ha, Cumberland Island offshore 13,135ha, Sapelo Island NES 3,745ha, Lewis Island NA 6,000ha, Wolf Island NWR 2,075ha, and Gray's Reef 5,672ha. Buffer zone: Blackbeard Island NWR 2,274ha, Little St Simon's 931ha, Altamaha SWMA 10,040ha and R.J. Reynolds SWR 3,336ha.

**LAND TENURE** All areas within both the core and buffer area are, with minor exceptions, owned by the State of Georgia or the federal government. Of the core areas, approximately 233ha are owned by the State and 16,330ha federally owned. Privately owned lands cover 1,684ha.

**ALTITUDE** 0-20m

**PHYSICAL FEATURES** This subdivision comprises a barrier coast with a gently sloping coastal plain and wide continental shelf. It includes extensive marsh-dominated estuaries the largest being that of Altamaha River. Many of the islands are Pleistocene-cored barrier islands with Holocene beaches, formed in response to fluctuations in sea level. The dominant energy source is tidal, with fluctuations in the mesotidal range (2-3m). The offshore area has a sloping sand bottom with outcrops of hard limestone which form the basis for live-bottom reef communities which occur in the Gray's Reef area. Gray's Reef is located in 70m of water and has a moderate relief of up to two metres and is more typical of communities found further offshore. The area is subject to weathering, with a complex array of features including ledges, caves, overhangs and areas of shifting

sand. This reef was formed between 20,000 and 40,000 years ago in a shallow embayment experiencing fluctuations in sea level and wave energy. It was not formed by tropical corals but by brines percolating through the local sediments along a bar or shoal and changing their chemical composition to form rock. Water temperatures range between 14°C and 28°C during the year.

**CLIMATE** Mean annual temperature is 20.4°C, mean annual precipitation is 1232mm.

**VEGETATION** Communities with some dominant species in brackets include: dunes (sandspur Cenchrus tribuloides, sea oats Uniola paniculata, beach pennywort Hydrocotyle bonariensis, Russian thistle Salsola kali); interdune flats (bayberry, saw palmetto Serenoa repens, Spanish bayonet Yucca sp.); upland forests (live oak Quercus virginiana, palmetto, magnolia and pine Pinus sp.); fresh water ponds (emergent grasses, sedges, rushes, duckweed Lemna minor); salt marsh (smooth cordgrass Spartina alternifolia); coastal swamp forest (sweetgum Liquidambar styraciflua, bald cypress Taxodium distichum, tupelo Nyssa aquatica); marine (planktonic and benthic algae; intertidal algae). On Lewis Island there is a virgin stand of bald cypress which are estimated to have been undisturbed for 1200 years but much of the on high ground forest is regrowth from about 1900 onward. There is a species list for the inshore part of the subdivision. Gray's reef supports a mixture of temperate and tropical species, including at least 15 seaweeds.

**FAUNA** Rare and endangered species include the loggerhead sea turtle Caretta caretta (V), eastern brown pelican Pelecanus occidentalis, American alligator Alligator mississippiensis, West Indian manatee Trichechus manatus (V), right whale Eubalaena glacialis (E), the endemic Cumberland Island pocket gopher Geomys cumberlandius and endemic subspecies of: the Anastasia Island cotton mouse Peromyscus gossypinus anastasiae, Blackbeard Island deer Oedicoileus virginianus nigribaris, St. Simon's Island raccoon Procyon lotor litoreus and green rat snake. Bald eagle Haliaeetus leucocephalus, a nationally endangered species, nests on Cumberland Island. Gray's Reef hosts rich populations of fish and a variety of corals and is the northern limit of many tropical species and the southernmost part of the range of many temperate species. For faunal lists see Johnson et al. (1974), Hillestad et al. (1975) and UNEP/IUCN(1988).

**CULTURAL HERITAGE** No information

**LOCAL HUMAN POPULATION** No information

**VISITORS AND VISITOR FACILITIES** Blackbeard Island has 10,000 visitors each year and has a campground, boat dock, fishing, wildlife observation and hunting facilities here. Cumberland Island National Seashore has a visitors' centre, five campgrounds and nearly 20 trails. Gray's Reef attracts divers and recreational fishermen and spearfishing as well as hook and line fishing is allowed. The reef is a popular all-year round site for open ocean diving training. It can be reached by private or (to a limited extent) by hired boat, the journey taking from one to three hours, depending on the departure point, type of vessel and sea conditions. Regular educational programmes for the general public are run on Cumberland by the National Park Service, on Sapelo by the Georgia Department of Natural Resources and the University of Georgia Marine Institute and on Gray's Reef by the University of Georgia Marine Extension Centre at Skidaway Island.

**SCIENTIFIC RESEARCH AND FACILITIES** The most outstanding feature of this subsection is the 30 years of scientific research that has been carried out at the Sapelo Island University of Georgia Marine Institute. There is also a growing

commitment to terrestrial barrier island ecology on Cumberland Island and to marine research at Gray's Reef. On Cumberland Island the effects of feral horses grazing the saltmarshes is being studied in conjunction with horse and white-tailed deer Odocoileus virginianus habitat use. Short-term monitoring has occurred at Sapelo almost continuously over the last 30 years, but there had been no commitment to long-term monitoring of specific biological, physical or chemical parameters, with the exception of climate. Plans for long-term monitoring are being developed. Marine turtle nesting is being studied with data available for the past 15 years and marine mammals are also monitored. The state monitors water quality and commercial fisheries production in the Altamaha River, estuaries and inshore waters. Research facilities are outstanding at Sapelo, with laboratories, library, computers, research vessels and accommodation. Cumberland has a small laboratory and dormitory accommodation. Experimental plots have been established on Sapelo (estuary) and Cumberland (estuary and terrestrial). Research at Gray's Reef takes place principally through the Skidaway Institute of Oceanography, Savannah.

**CONSERVATION VALUE** The reserve includes a barrier coastline with many marsh-dominated estuaries. An offshore area of reef is included where a number of marine species are found at either the northern or southern limits of their ranges. Endangered species such as West Indian manatee Trichechus manatus (V), right whale Eubalaena glacialis (E) and loggerhead sea turtle Caretta caretta (V) occur within the reserve. There are also relatively undisturbed marsh communities and a variety of successional coastal habitats.

**CONSERVATION MANAGEMENT** Gray's Reef National Marine Sanctuary has an adopted management plan. Sapelo Island National Estuarine Sanctuary has a draft management plan. Cumberland Island National Seashore has a Final General Management Plan. Lewis Island Natural Area is included in proposed plan for the Lower Altamaha River. Marine Sanctuary regulations at Gray's Reef prohibit trap fishing and trawling but commercial fishing prospects are limited anyway in this area. Hook and line fishing is allowed and occasionally commercial catches of mackerel, blue fish and cobia are taken. Collection of marine organisms is prohibited except under permit for scientific purposes. On Cumberland Island there is a hog control programme and trapping is carried out four times a year; 1500 animals have been removed since 1975.

Zoning comprises core areas: Blackbeard Island Wilderness, Sapelo Island National Estuarine Sanctuary, Gary's Reef National Marine Sanctuary, Lewis Island Natural Area, Wolf Island National Wildlife Refuge, Cumberland Island National Seashore and offshore for three miles. Buffer zone: Blackbeard Island National Wildlife Refuge (non-wilderness portion), Richard J. Reynolds State Wildlife Refuge, Altamaha State Waterfowl Management Area, Little St. Simon's Island.

**MANAGEMENT CONSTRAINTS** Most of the reserve was harvested for timber or under cultivation during the 19th century. Some buildings do exist but do not dominate the landscape. Pollution levels are low except for the evidence of pollutants from a paper mill in the air near the southern end of Cumberland Island. Pollution risks are present from such facilities as the Kings Bay Nuclear Submarine Base west of Cumberland Island. Cumberland Island has recently been invaded by armadillos Dasypus novemcinctus although this may be a natural range extension but this is affecting terrestrial ecosystems. There are also possible threats to this island from feral populations of horses and hogs, the latter causing damage by rooting.

**STAFF** About 50, including 40 involved in administration, control and resource

management and 10 in research.

BUDGET No information

LOCAL ADDRESSES

Blackbeard Island National Wildlife Refuge and Wolf Island National Wildlife Refuge: Georgia Coastal Complex, US Fish and Wildlife Service, PO Box 8487, Savannah, GA 31412

Sapelo Island National Estuarine Sanctuary, R.J. Reynolds Wildlife Refuge: Georgia Department of Natural Resources, Sapelo Island, GA 31327

Gray's Reef National Marine Sanctuary: Office of Ocean and Coastal Resource Management, NOAA/US Dept. of Commerce, 3300 Whitehaven St. NW, Washington, DC 20036

Lewis Island Natural Area: Altamaha State Waterfowl Management Area, Dept. of Natural Resources, Darien, GA 31305

Cumberland Island National Seashore: P O Box 806, St. Mary's, GA 31558

Little St. Simon's Island: P.O. Box 1096, St. Simon's Island, GA 31522

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## UNITED STATES OF AMERICA

NAME Central California Coast Biosphere Reserve

IUCN MANAGEMENT CATEGORY I (Strict Nature Reserve)  
IV (Managed Nature Reserve)  
IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 1.07.06 (Californian)

GEOGRAPHICAL LOCATION Located to the west of San Francisco bay and north of San Francisco city. The offshore boundary extends six nautical miles seaward into the eastern Pacific Ocean from the mean highwater line in the northern part of the Gulf of Farallones National Marine Sanctuary, then follows a 12 nautical mile arc around the Farallon Islands and extends back to the shore at Rocky Point, south of Bolinas Lagoon. Inland it includes Point Reyes National Seashore, southwards including Golden Gate National Recreation Area, parts of San Francisco bay and two main islands, Alcatraz and Angel Isle. It covers three counties, Marin, San Francisco and San Mateo, State of California. Approximately 37°-38°N, 122°W

DATE AND HISTORY OF ESTABLISHMENT Designated as a biosphere reserve in November 1988, all core zones have strict protection under legal mandate of management authorities. The Gulf of Farallones National Marine Sanctuary (GFNMS) was designated in 1981 in accordance with title III of the Marine Protection, Research and Sanctuaries Act; Port Reyes National Seashore (PRNS) legislation was passed on 13 September 1962; Golden Gate National Recreation Area (GGNRA) legislation in 1972. There are also six designated areas of special biological significance and one national wildlife refuge.

AREA 404,863ha (core area 40,500ha; buffer zone 355,290ha and transition zone 9,073ha). GFNMS encompasses 948 square nautical miles of nearshore and offshore waters.

LAND TENURE Federal, state and local

ALTITUDE 1,300m below sea level to 730m

PHYSICAL FEATURES The reserve includes open ocean with marine islands, coastal zones, tidal mudflats, rocky terraces, and salt marshes leading into coastal ranges, the watershed zone of the Central Coast range. There is a complete spectrum of marine habitats, ranging from intertidal zones to pelagic and deep oceanic habitats representative of the Oreganian marine province of the Eastern Pacific Boreal region. This coastal zone of the Pacific is characteristic of the cold temperate waters of the eastern Pacific marine region that flows as the California Current from Point Conception to British Columbia (NOAA, 1987). The Gulf of the Farallones is a broad and shallow extension of the continental shelf, interrupted along its western edge by the granite ridge of the Farallon Islands. South-west of the Farallon Islands, the continental shelf drops abruptly to depths of 400 fathoms. The region covers two major geological zones, the Pacific and American continental plates which are separated by a rift zone or fault line, the San Andreas Fault, along with many smaller associated faults. A tectonically active zone, the area consists primarily of sedimentary and meta-sedimentary rocks to the north (Marin county) with some mesozoic intrusives, granite, and tertiary fault and mesozoic metamorphics to the east, notably the Franciscan formation and coast range (NOAA, 1987; MAB USA, 1988).

CLIMATE Mediterranean with dry summers and winters with excess moisture. Marine fogs characteristically occur in summer. Mean annual precipitation of 2000mm at 730m altitude and 500-750mm at sea level. Maximum average temperature of the warmest month is 16.5°C, and minimum average temperature of the coldest month is 9.5°C (MAB USA, 1988).

VEGETATION In the marine zone, vegetation includes dense kelp beds dominated by bull kelp Nereocystis spp. and to a lesser extent giant kelp Macrocystis spp. and eelgrass meadows. There are three main terrestrial vegetation communities; coastal chaparral, coastal shrublands and mixed broadleaf and conifer woodland. The chaparral is represented by a diversity of species including chamise, manzanita Arctostaphylos spp., Ceanothus spp. and Castanopsis spp. Typical shrubland communities are dominated by coastal sagebrush, consisting primarily of California sage and white sage. There are also seashore communities of prairie grasses and salt marsh of Salicornia spp. Woodlands consist of mixed redwood Sequoia sempervirens along with tan oak Lithocarpus spp, madrone Arbutus spp., live oak Quercus agrifolia and douglas fir Pseudotsuga spp. Notable plants of national threatened status include ravens manzanita Arctostaphylos hookeri ssp. ravenii, and state listed Ceanothus masonii and Clarkia francisca (for a full species list see MAB USA, 1988).

FAUNA Although the marine fauna is believed to be extremely diverse, survey work is far from complete partly due to the difficulty of sampling at depth. Over 20 species of fish are common to the subtidal and pelagic environments, and include such species as salmon Salmo spp., rockfish Sebastes spp. and sea bass Senanidae. The area is represented by an avifauna including well over 123 species of aquatic bird. Large nesting colonies and migrant populations are found on the Farallon Islands and Point Reyes, including nesting colonies of brown pelican Pelecanus occidentalis and notable raptors such as peregrine falcon Falco peregrinus and bald eagle Haliaeetus leucocephalus (a more complete bird list is found in NOAA, 1987). Up to 22 species of marine mammal are regularly observed; five species of pinniped and 17 species of cetacean, mostly seen on migration. These include gray whale Eschrichtius glaucus, Pacific humpback whale Megaptera novaengliae, California sea lion Xalophus californianus, Steller's sea lion Eumetopias jubata, harbor porpoise Phocoena phocoena (K), dall porpoise Phocoenoides dalli, harbor seal Phoca vitulina and northern elephant seal Mirounga angustirostris (for full list see NOAA, 1987).

CULTURAL HERITAGE Archaeological and historical investigations have uncovered over 100 archaeological sites in Point Reyes NS, evidence of native Miwok Indian communities. The more recent historical period is rich in a culture ranging from Spanish and British explorers to Mexican ranchers, Asian and European gold seekers and 125 years of continuous immigration from Europe. Sir Francis Drake explored the area in his ship the Golden Hind in 1579. In 1595 Sebastian Rodriguez Cermeno's galleon was wrecked off San Francisco. This ship and 30 other wrecks have been located in the area (NOAA, 1987). Historic features include the infamous Alcatraz, Fort Point National Historic Site, Fort Funston, West Fort Miley, Fort Mason and numerous batteries including Battery Chamberlin with its 95,000lb gun dating from 1906 (National Parks service, 1982). The preserved antique ships in the bay include the schooner C.A. Thayer, the steamer Wapama, hay-scow Alma and the liberty ship Jeremiah O'Brien built in 1943.

LOCAL HUMAN POPULATION Approximately 5.6 million people live in the Nine Bay Area counties although there are no inhabitants in the core area, buffer zone or transition zone of the reserve except park staff in the buffer and transition zones. The area supports many large commercial fisheries, some controlled



livestock grazing and some of the west coast's busiest shipping lanes.

VISITORS AND VISITOR FACILITIES There are up to 1 million visitors each year. Of the wide range of facilities and activities are numerous recreational parks, museums, galleries, canoe and boat excursions, swimming beaches, hiking trails, picnic areas, campgrounds, horse trails and stables. Popular activities include sports fishing for salmon, whale watching and offshore excursions.

SCIENTIFIC RESEARCH AND FACILITIES The first studies date back to ornithological observations in the 1850s, forming the basis of at least 130 years of records, and ongoing monitoring now undertaken by the Point Reyes Bird Observatory which was set up in 1972 (NOAA, 1987). Other establishments include weather stations, the National Marine Fisheries Service Tiburton Laboratory, Bodega Bay Marine Laboratory, Long Marine Laboratory (University of California) and research is undertaken by Stanford University, California State University and World College West. Scientific research is encouraged, particularly where results can help resolve key management questions. The Gulf of the Farallones NMS management plan outlines general priorities for research over a 10-year period. These include: baseline studies for populations and habitats where distribution and other basic characteristics remain poorly understood; directed monitoring studies focusing on indicator species and representative habitats in collaboration with other agencies; analytical studies aimed at determining the cause of impact (NOAA, 1987).

CONSERVATION VALUE There is a complete spectrum of marine habitats, ranging from intertidal zones to pelagic and deep oceanic habitats representative of the Oregonian marine province of the Eastern Pacific Boreal region. There are extensive kelp beds offshore and the marine fauna is extremely diverse and has not been completely recorded yet, owing to the difficulties of exploring some of the depths involved. At least five species of pinniped and 17 species of cetacean are recorded regularly, this area being on a major migration route, and a large number of bird species are resident or pass through on migration. A number of historic sites are included, such as the infamous Alcatraz, Fort Point National Historic Site, Fort Funston, West Fort Miley and Fort Mason.

CONSERVATION MANAGEMENT The reserve was established and is of particular value for its relatively undisturbed marine islands, coastal prairies, freshwater marshes, forests and coastal wetlands. It possesses some of the most diverse and largest Eastern Pacific populations of seabirds and pinnipeds south of Alaska, and the largest concentrations of breeding marine birds in the continental United States (NOAA, 1987). There are seven nationally threatened species, four species on the State protected list, and a number of species protected under the marine mammal protection act (MAB USA, 1988). Permitted activities include sportfishing and recreation, commercial fishing and mariculture, controlled livestock grazing and burning of chaparral, tourist development and military operations.

The biosphere reserve is currently managed in separate units: Point Reyes National Seashore and Golden Gate National Recreation Area by the National Parks Service; the Gulf of Farallones National Marine Sanctuary by the National Oceanic and Atmospheric Administration; Farallon National Wildlife Refuge by the United States Fish and Wildlife Service; Mount Tamalpais, Tomales Bay and Samuel P. Taylor state parks by California State Parks and Recreation Department. The main area is covered under the management plan of Gulf of the Farallones national marine sanctuary, which was prepared in 1987 by the NOAA, US Department of Commerce (NOAA, 1987). This management plan was divided into an action plan with three programme areas: resource protection, research, interpretation and education. The

plan ensures improved protection of the marine environment and resources as highest priority, together with compatible multiple-use of the ocean area, increased public awareness and support, and management-orientated research programmes (NOAA, 1987). The State Department of Fish and Game is the main agency authorised to conduct on-site surveillance and enforcement. The National Park Service provides assistance to the division in day-to-day administration, and for development and implementation of the education programme, on-site interpretation and research programmes (NOAA, 1987). NOAA has cooperative agreements with the California Department of Fish and Game and the National Park Service based at the Golden Gate NRA, allowing each agency to assist in mutual management of the reserve. There are also inter-agency task forces in Point Reyes NS, Golden Gate NRA and California state parks. There is a public hearing process and a citizens' advisory commission. A steering group and advisory council has been proposed for the biosphere reserve (MAB USA, 1988).

MANAGEMENT CONSTRAINTS One of the greatest threats to the reserve is the excessively high levels of water and atmospheric pollution and the continuing potential danger from oil spills. There is heavy use of the beach and dune areas and fishing is locally uncontrolled (NOAA, 1987; MAB USA, 1988). Increasing numbers of seabirds and small cetaceans are becoming entangled in gill nets (NOAA, 1987).

STAFF Over 50 (administration staff 25; education staff 10; research staff 23, and technical support 11) (MAB USA, 1988).

BUDGET No information

LOCAL ADDRESSES Coordinator, Point Reyes Bird Observatory, 4990 Shoreline Highway, Stinson Beach, California 94970

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## UNITED STATES OF AMERICA

NAME New Jersey Pinelands National Reserve and Biosphere Reserve

IUCN MANAGEMENT CATEGORY V (Protected Landscape)  
IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 1.05.05 (Eastern Forest)

GEOGRAPHICAL LOCATION The Pinelands lie within the Atlantic coastal plain province, bordering the Atlantic ocean. The Delaware River is approximately 15km from the western boundary of the reserve which is bordered to the north-west by the Philadelphia-Trenton New Jersey industrial complex. The Pinelands are within 160km of major urban centres such as New York City and the Washington/Baltimore complex. Pinelands Reserve is included in seven counties and 56 municipalities within New Jersey state. Approximately 39°45'N, 74°45'W

DATE AND HISTORY OF ESTABLISHMENT Originally accepted as an unit part of the South Atlantic Coastal Plain Biosphere Reserve in 1983 and redesignated and accepted as a separate biosphere reserve in November 1988 due to problems arising from the considerable distances between units in the original biosphere reserve, the nearest being 150km from Pinelands. Decrees protecting the area: Coastal Area Facility Review Act September 1973; Pinelands Environmental Council 1975; National Park and Recreation Act 1978; Government executive order #71 February 1979; NJ Legislature Pinelands Protection Act June 1979. Also designated as a National Science Foundation ecological reserve and as a national reserve and the first area of national concern in the US (Hales, 1983; New Jersey Pinelands Commission, 1980; US MAB, 1988).

AREA 445,300ha (core area 149,300ha and buffer zone 296,000ha) (New Jersey Pinelands Commission, 1980; US MAB, 1988).

LAND TENURE State and private ownership; about 5% of the reserve is under agriculture and 9% is residential/commercial. National and state holding include Brigantine Wildlife Refuge, Lebanon State Forest, Wharton Tract and Bass River State Forest. State wildlife areas total 6,062ha; state forests and parks 45,400ha; county park 6.8ha; federal wildlife refuge (Brigantine) 8,097ha (US MAB, 1988).

ALTITUDE 0-63m

PHYSICAL FEATURES The Pinelands are a mosaic of forest, swamps and bogs located on the Atlantic Outer Coastal Plain. The reserve is characterised by a gently rolling landscape and contains the largest freshwater aquifer in the mid-Atlantic region, the Cohansey aquifer. The water table is rarely more than 7m from the surface and often at depths of less than 1m and the aquifer has a remarkably stable water regime. The surface deposits are dominated by the Cohansey and Kirkwood formations (Tertiary deposits). These unconsolidated formations are comprised primarily of quartz sands with minor amounts of gravel, silt and clay. The area has not been glaciated and there is no bedrock at or near the surface. The solid geology of the region is complex, the rocks of the 200-170 million year old Atlantic Coastal Plain varying in thickness from 400m to 1,830m. Included in Pinelands National Reserve are 11 major drainage basins including the River Mullica and its tributaries (Bass, Wading, Batsto and Oswego rivers), Great Egg Harbor River, Forked River, Toms River and Rancocas Creek. Most rivers flow into

the Atlantic barrier bays or the Delaware Bay, the Rancocas flowing into the Delaware River. The soils are sandy and acidic with some podzols and have little ability to retain moisture and nutrients or to filter pollutants. They are extremely poor in agricultural terms. Ultisols and entisols occur in the uplands; spodosols and histosols occur in the lowlands. Fire is also an extremely important factor in the maintenance of the characteristics of the Pinelands and has occurred frequently for at least 10,000 years. It is the dominant factor determining forest species composition (Hales, 1983; New Jersey Pinelands Commission, 1980; US MAB, 1988).

**CLIMATE** Continental climate with humid and temperate variations; mean winter temperature is 0-2°C; summer temperature 22-24°C. Areas of the national reserve are affected by the Atlantic Ocean. Mean annual precipitation is 1168mm at an altitude of 200m (New Jersey Pinelands Commission, 1980; US MAB, 1988).

**VEGETATION** There are 800 species of vascular plants, of which 270 are introduced, 5 endemic and 71 endangered species. Fourteen species of plant reach the southernmost extensions of their ranges in the Pinelands. The most typical vegetation comprises pine-dominated communities maintained by frequent fires; in the absence of burning, oaks and other hardwoods would dominate. The dominant fire-resistant species are pitch pine Pinus rigida, short-leaved pine P. echinata and scrub oaks Quercus marilandica and Q. illicifolia, with some Q. alba and Q. velutina. Other habitat types include salt marsh, white cedar swamp, Sphagnum bogs, cranberry bogs, pygmy pine plains and hardwood swamp (Acer rubrum, Nyssa sylvatica, Betula populifolia) and Atlantic white cedar swamps (Chamaecyparis thyoides and Magnolia virginiana). Coastal wetlands include Spartina alterniflora, S. patens, Juncus gerardi, Distichlis spicata and Salicornia spp. (New Jersey Pinelands Commission, 1980). There are extensive areas of cranberry Vaccinium macrocarpon and blueberry V. corymbosum which are exploited commercially, but many of the soils are too poor to allow arable crops to be grown (Hales, 1983; New Jersey Pinelands Commission, 1980).

**FAUNA** There are 34 species of mammals, 299 species of birds, 59 species of amphibians and reptiles and 91 species of fish. A species list for the reserve is available (New Jersey Pinelands Commission, 1980). More than 100 species of animal reach the northernmost extent of their ranges in the Pinelands. The largest game species is white-tailed deer Odocoileus virginianus. Bear Ursus americanus and bobcat Lynx rufus have been exterminated (New Jersey Pinelands Commission, 1980). Typical breeding birds of the forests include rufous-sided towhee Pipilo erythrophthalmus which is reported to be the most abundant bird in the Pinelands (Hales, 1983; New Jersey Pinelands Commission, 1980).

**CULTURAL HERITAGE** The Pinelands have been occupied and exploited by humans over the last 10,000 years. As a result of a statewide survey in 1912, a dozen prehistoric sites were identified, the earliest dating from the Paleo-Indian tradition of 10,500BC to 8,000BC (New Jersey Pinelands Commission, 1980). There are a number of abandoned town sites representing 18th and 19th century business ventures (New Jersey Pinelands Commission, 1980).

**LOCAL HUMAN POPULATION** The reserve contains a number of scattered towns and villages, including Chatsworth, Batsto and Greenbank. There is an average density of 180 inhabitants per sq.km. Atlantic City to the east is the largest nearby urban centre and Hammonton is an important local trade and agricultural centre. Up to 500,000 inhabitants are located in the buffer zone and a few scattered residences in the core area. Cranberry and blueberry culture are among the most important economic activities in the reserve, as are Atlantic white cedar

Chamaecyparis thyroides harvesting and silviculture (US MAB, 1988).

VISITORS AND VISITOR FACILITIES Of interest to tourists for its landscape value, there is an extensive policy in the reserve to promote local participation in its management and to promote environmental education of local people and visitors. Interpretation centres are available, notably for school children. Sports fishing and hunting are promoted. Access is primarily by automobile (US MAB, 1988).

SCIENTIFIC RESEARCH AND FACILITIES Currently there are 50 national research scientists working in the reserve and four commission research staff (US MAB, 1988). There is an extensive range of research activities, both applied and basic (US MAB, 1988). Rutgers University maintains a blueberry/cranberry experiment station and a marine station. USFS has conducted a number of forestry oriented studies over a long period of time, Brigantine has focused on wildlife studies. Much of the basic scientific knowledge of the Pine Barrens has been summarised (Forman, 1979; US MAB, 1988). In 1981, the Rutgers Division of Pinelands Research was established to help coordinate research efforts in the area. Studies include monitoring of water quality and forest fire management, climate, vegetation, hydrology and pollution studies. Field stations are located at Lebanon USFS, Rutgers, Little Egg, Blueberry/Cranberry Station, Atlantic City, Chatsworth and Hammonton (US MAB, 1988). In addition there is an air pollution monitoring station, climatological monitoring station, conference facilities and hydrological monitoring station as well as lodging for 14 visiting scientists (US MAB, 1988). Planned resource information includes geographical information systems and satellite imagery. There are ongoing inventories of vertebrates and flora, climate and air quality and ecological data management systems (US MAB, 1988).

CONSERVATION VALUE Of major value to nature conservation are the minimally disturbed forest ecosystems and internationally threatened plant species. The site is of importance also for its diverse research work on all branches of the sciences and geography. A number of plants occur here at the most northerly extensions of their ranges, while this is the most northerly area for many species of animal. The wet, infertile soils have discouraged development of the area and maintained its almost unique character. A number of notable archaeological sites are also included, giving evidence of Indian occupation.

CONSERVATION MANAGEMENT A Comprehensive Management Plan (CMP) was prepared in 1979 and adopted by the Pinelands Commission in November 1980 (New Jersey Pinelands Commission, 1980). Article 5 outlines standards and Article 6 relates to activities subject to management. A 'land capability' map defines distribution of types. Upland pine-oak forest land use, development, land clearing, forestry activities, are all regulated by provision of the CMP. Approximately 110,000ha of forest are managed as conservation lands by the State of New Jersey. The CMP also delimits a number of Preservation Areas (covering 337,000ha of which 60% are publicly owned) where human activities are strictly limited to those compatible with natural processes and Protection Areas where human influences remain minimal. Forest Areas (420,000 acres) allow resource related uses and low density residential development while Rural Development Areas (145,000 acres) allow for moderate density development. Regional Growth Areas (119,000 acres) permit reasonably high density residential development, commercial and industrial development. There are also 48,000 acres of Military and Federal Installation Areas. Under provisions of the CMP, development in all wetlands is prohibited and controlled timber harvesting and cranberry or blueberry agriculture are their only significant use. Coastal wetlands are managed and protected by several state and federal programmes which prevent the destruction of coastal wetlands. Mining of

sand and gravel is limited to areas approved prior to the passage of the Pinelands legislation. Activity is strictly regulated and reclamation is required. Coastal areas are not subject to the CMP but are under the jurisdiction of CAFRA (Hales, 1983; New Jersey Pinelands Commission, 1980; US MAB, 1988).

MANAGEMENT CONSTRAINTS Over the past 300 years the area has been affected by extensive timbering, mining of iron sand and gravel, hunting and residential development but development has usually occurred in areas of better soils which are not those most characteristic of the region. However, in the past 30 years, increasing population pressure and the growth in holiday and retirement homes have resulted in expanding residential development. As recently as the 1960s public officials were considering the area as a site for an international airport (New Jersey Pinelands Commission, 1980). The relative emptiness of the Pinelands makes them a likely destination for illegal waste dumping which has increased with the rising costs of toxic waste disposal. Waste dumping is particularly dangerous in this area as the soils are so permeable and have little filtering effect on pollutants. Other threats include forest fires, potential expansion of urban centres and atmospheric pollution from five fossil fuel-burning power plants in southern New Jersey (Hales, 1983; New Jersey Pinelands Commission, 1980; US MAB, 1988).

STAFF The Pinelands Commission has 45 staff and the Rutgers division of Pinelands Research up to 4 staff of which 43 are involved in administration, control and resource management, four in research and two in training and education (US MAB, 1988).

BUDGET Funding includes US\$2.4 million from the New Jersey Pinelands Commission; and US\$60,000 from the Division of Pinelands Research (US MAB, 1988).

LOCAL ADDRESSES New Jersey Pinelands Commission, Springfield Road, PO Box 7, New Lisbon, NJ 08064

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## UNITED STATES OF AMERICA

NAME Southern Appalachian Biosphere Reserve

IUCN MANAGEMENT CATEGORY I (Scientific Reserve)  
II (National Park)  
IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 1.05.05 (Eastern Forest)

GEOGRAPHICAL LOCATION In the upper Tennessee Valley including the provinces of southern Blue Ridge, Ridge and Valley, Cumberland Plateau and Upper Range Piedmont. The nearest city is Atlanta, Georgia. The entire reserve is situated in north-east Tennessee, western North Carolina, north-western South Carolina, south-eastern Kentucky and south-west Virginia. Within this area, the three subregions with core and buffer zones are widely separated and make up less than 4% of the whole biosphere reserve, the rest being transition zone. The largest subregion, Great Smoky Mountains National Park, is about equidistant from the other two. Approximately 35°-36°N, 83°-84°W

DATE AND HISTORY OF ESTABLISHMENT Formed as a distinct biosphere reserve cluster in November 1988 and including Great Smoky Mountains National Park Biosphere Reserve (originally designated in 1976), Coweeta Hydrological Laboratory Biosphere Reserve (designated in 1976) and Oak Ridge Environmental Research Park. Covered under national legislation, state and administrative regulations. It is also a national environment research park, long-term ecological research site of the National Science Foundation, and an International Biological Programme research site (US MAB Committee, 1988).

AREA 215,596ha; the core area totals 180,719ha (in addition there is a non-delineated transition zone of about 6.2 million hectares, called the Upper Tennessee valley) (US MAB Committee, 1988).

LAND TENURE Principally federally owned

ALTITUDE 226-2,025m

PHYSICAL FEATURES The dominant topographic feature is the mountains of Blue Ridge province which include 16 peaks above 1,800m. To the east are the rolling hills of the Piedmont; to the west are hills and valleys, whilst the north-west region encompasses the boundary with the Cumberland plateau. The main rock types are gneisses, schists, and granites of Blue Ridge and sandstones, shales and limestones of the Ridge and Valley province. Most of the soils are ultisols and inceptisols (US MAB Committee, 1988).

CLIMATE Relatively mild, humid summers and cool winters. Precipitation is fairly evenly distributed throughout the year. There is a marked altitude gradient associated with climatic characteristics. The maximum average temperature of the warmest month is 30°C and minimum average temperature of the coldest month -2°C. Mean annual precipitation ranges from 1400mm at an altitude of 240m to 2500mm at 1,400m (US MAB Committee, 1988).

VEGETATION This comprises forests, heath lands, cliffs, cedar barrens and wetlands. Mixed deciduous forests are represented by oak/hickory and pine forests of Pinus spp., Quercus spp., tulip tree Liriodendron tulipifera, Acer spp, Tilia



heterophylla, Carya spp., Betula spp., Cornus florida, Kalmia latifolia, Tsuga canadensis and Rhododendron maxima. The area is a Pleistocene refuge and thus an outstanding example of diverse Arcto-Tertiary geoflora era, with a high number of temperate species. There are 130 tree species, over 1,400 species of flowering plants and 2,200 others in Great Smoky Mountains National Park alone. Some 30% of the park is virgin forest and consists of oak and pine woods dominated by stands of Quercus prinus, Pinus rigida and P. pungens. There are also spruce/fir forests of red spruce Picea rubens and Fraser fir Abies fraseri. Threatened species include Glyceria nubigena, Geum radiatum, Cacalia rugelii, Aureolaria patula, Cimicifuga spp. and Saxifraga careyana (US MAB Committee, 1988).

**FAUNA** Dominated by forest species including rare species such as peregrine falcon Falco peregrinus and red-cockaded woodpecker Picoides borealis (V) (US MAB Committee, 1988). Common species include white-tailed deer Odocoileus virginianus, black bear Ursus americanus, grey squirrel Sciurus carolinensis, raccoon Procyon lotor, woodchuck Marmota monax, ruffed grouse Bonasa umbellus and wild turkey Meleagris gallopavo. There is a total of 200 bird species and 70 species of fish. Insect species new to the area include caddisflies Psilotreta sp., Hydroptila coweetensis and a carabid beetle Pterostichus sp. Species of salamanders occurring over ecological gradients include dusky salamanders Desmognathus spp. and shovel-nosed salamanders Leurognathus spp.

**CULTURAL HERITAGE** Archaeological sites include prehistoric remains dating back 15,000 years. There are also structures dating from the middle 1800s to 1920, including the finest collection of log buildings in the USA. The National Register of Historic Places includes three historic districts, eight structures and 28 buildings.

**LOCAL HUMAN POPULATION** Approximately 100 people inhabit the core area of Great Smoky Mountains National Park. Activities in all units include agriculture, forestry, fishing, livestock grazing, tourism and controlled land management. Crops include corn, hay, vegetables, fruit, tobacco and marijuana (US MAB Committee, 1988).

**VISITORS AND VISITOR FACILITIES** An estimated 10 million people visit the reserve areas each year. Environmental education for school children and students is an essential part of each unit's activities (US MAB Committee, 1988).

**SCIENTIFIC RESEARCH AND FACILITIES** The reserve is an International Biological Programme research site. The estimated number of researchers at the site include 200 nationals and 10 foreign scientists. A wide variety of research is being undertaken at all three reserve units. Ongoing projects include those on general ecological data management systems, satellite imagery, vegetation surveys, hydrological data collecting and limnological surveys, atmospheric and climatological data gathering and inventories of mammals, invertebrates and vascular plants (US MAB Committee, 1988). At Coweeta Hydrological Laboratory extensive measurement of streamflow and precipitation began in 1934; streamflow and precipitation chemistry have been measured continuously since 1968. The mission of Forest Service research over the past 50 years has been to study the effects of forest management practices on the quantity, timing and quality of streamflow, and to develop methods and procedures for predicting and mitigating impacts. Current emphasis is on parameters of water quality. Coweeta has a history of cooperative research; within the past 15 years over 50 formal agreements have been initiated with universities and other institutions. Coweeta has participated in numerous international programmes, including FAO training programmes; US/International Hydrologic Decade; and the US/International

Biological Program, as one of the five intensive research sites of the Eastern Deciduous Forest Biome. The units are also involved as monitoring and research site in both the National Atmospheric Deposition Program and the National Acid Precipitation Assessment Program, and participates in various regional and national research programmes funded by NSF, DOE, EPA, and EPRI.

CONSERVATION VALUE The area is typical of the rich Southern Appalachian flora and fauna. The region is a Pleistocene refuge and includes remnants of a diverse Arcto-Tertiary geoflora, with a large number of temperate species. Some 30% of the park is virgin forest and consists of oak and pine woods dominated by stands of Quercus prinus, Pinus rigida and P. pungens.

CONSERVATION MANAGEMENT A master management plan exists. Forest management includes selective forest cutting and animal population control along with regulated hunting and fishing; eradication of exotic plant and animal species occurs in Great Smoky Mountains National Park. Insect spraying for adelgids is undertaken in the spruce and fir forests (US MAB Committee, 1988). The core area of the Coweeta unit consists of Coweeta and Dryman Fork basins. Both basins have a buffer zone administered by the USDA Forest Service, National Forests in North Carolina. Oak Ridge National Laboratory is managed by the US Department of Energy and Great Smoky Mountains National Park by the US National Park Service.

MANAGEMENT CONSTRAINTS Adverse effects upon the reserve include air pollution, poaching, introduction of exotic species, development of adjacent lands and visitor impacts. There is heavy infestation of two defoliators, snow-white eugonia Ennos subsignarius and fall cankerworm Alsophila pometaria at Coweeta. Small outbreaks of pine beetle Dendroctonus frontalis have also occurred (US MAB Committee, 1988).

STAFF Total of 620; 168 administrative, 108 university trained and 60 others; 121 for research and 30 for education (US MAB Committee, 1988).

BUDGET \$52,000,000 in 1988 (US MAB Committee, 1988)

LOCAL ADMINISTRATION Southern Appalachian Biosphere Reserve, c/o Great Smoky Mountains National Park, Gatlinburg, Tennessee 37738

#### REFERENCES

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**Southern Appalachian Biosphere Reserve: Coweeta Hydrological Laboratory Unit**

IUCN MANAGEMENT CATEGORY I (Scientific Reserve)  
X (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 1.05.05 (Eastern Forest)

GEOGRAPHICAL LOCATION In the southern Appalachian Mountains 22km south of Franklin, North Carolina. Approximately 35°03'N, 83°27'W

DATE AND HISTORY OF ESTABLISHMENT Approved as a biosphere reserve in June 1976

and integrated as a distinct unit of the Southern Appalachian Biosphere Reserve in 1988.

**AREA** 215,596ha (core area of 180,719ha and buffer zone of 34,877ha; the Upper Tennessee Valley forms the 6.2 million ha transition zone)

**LAND TENURE** Federal government, under administration of the USDA Forest Service

**ALTITUDE** 679-1,592m

**PHYSICAL FEATURES** The area lies within the Blue Ridge physiographic province of the Southern Appalachians. The underlying bedrock of the Coweeta Group consists of a series of meta-sedimentary and possibly meta-igneous rocks which overlie beds of the Tullulah Falls Formation of Precambrian origin. Biotite gneisses, meta-arkoses, meta-sandstones, quartzites, pelitic and biotite schists, and metagraywackes predominate. The regolith within the Coweeta Basin is deeply weathered and averages about 7m in depth. Soils include fully developed ultisols (hapludults) and immature inceptisols (dystrochrepts), with loam, sandy loam and stony loam textures. The topography is diverse and includes valley bottoms, coves, hill slopes and ridges. Approximately 69km of streams drain the area.

**CLIMATE** Precipitation is high and variable with an average of 1800mm at lower elevations to over 2500mm on upper slopes. Rainfall distribution is relatively uniform throughout the year, with an average of 113mm in October, the driest month and 197mm in March, the wettest. Mean annual temperature averages 12.6°C; the coldest month is January, with a mean temperature of 3.2°C. July is the warmest month, with a mean of 21.6°C.

**VEGETATION** Mixed, deciduous hardwoods of varying age structure cover the area. Dominant types include oaks Quercus spp., hickories Carya spp., maples Acer spp., tulip tree Liriodendron tulipifera, birches Betula spp., dogwood Cornus florida, pine Pinus rigida, laurel Kalmia latifolia and rhododendron Rhododendron maximum. Past experimental manipulations have resulted in scattered white pine Pinus strobus plantations and early successional stands of hardwoods. Chestnut Castanea dentata was once a major component of mature forest stands, but due to blight caused by the fungus Cryphonectria parasitica this species has declined.

**FAUNA** Animal species are dominated by common forest mammals such as white-tailed deer Odocoileus virginianus, black bear Ursus americanus, grey squirrel Sciurus carolinensis, raccoon Procyon lotor, woodchuck Marmota monax and birds include ruffed grouse Bonasa umbellus, wild turkey Meleagris gallopavo. Introduced wild pigs Sus scrofa occur at upper elevations in the Basin. New insect species which have been found in the area include caddisflies Psilotreta sp., Hydroptila coweetensis and a carabid beetle Pterostichus sp. Species of salamanders include dusky salamander Desmognathus spp. and shovel-nosed salamander Leurognethus spp.

**CULTURAL HERITAGE** No information

**LOCAL HUMAN POPULATION** None

**VISITORS AND VISITOR FACILITIES** There is a visitors' centre on site with information on research programmes, self-guided tours and slide-tape programmes describing the history and research of the area.

**SCIENTIFIC RESEARCH AND FACILITIES** Research is organised by the USDA Forest Service in its South-eastern Forest Experiment Station. Coweeta is a research

site of the National Science Foundation (NSF) Long-Term Ecological Research (LTER) program. Coweeta is also a monitoring and research site in both the National Atmospheric Deposition Program and the National Acid Precipitation Assessment Program, and participates in various regional and national research programmes funded by NSF, DOE, EPA, and EPRI. Participation in both LTER and IBP have been in coordination with the Institute of Ecology, University of Georgia. The LTER cooperative research program with the University of Georgia and other institutions are undertaking studies on the processes of nutrient cycling and productivity in undisturbed and disturbed forest ecosystems. Measurements of streamflow and precipitation began in 1934; about 1,000 gauge-years of streamflow records and 2,000 gauge-years of precipitation records have been collected. Other climatological data have been continuously collected and summarised over the past 50 years. The results of vegetation and fauna surveys are also available.

CONSERVATION VALUE The area includes relatively undisturbed communities typical of Southern Appalachian flora and fauna, including a variety of forest species.

CONSERVATION MANAGEMENT Research over the past 50 years has primarily involved studying the effects of forest management practices on the quality, quantity and timing of streamflow for prediction programmes. Taken collectively, Forest Service and cooperative research provides an unique and valuable opportunity to examine ecosystem processes at different spatial and temporal scales of resolution and to integrate process-level findings within the framework of watershed response. Coweeta has participated in numerous international programmes, including FAO training programmes; US/International Hydrologic Decade; and the US/International Biological Program as one of the five intensive research sites of the Eastern Deciduous Forest Biome. Managed by the USDA, the main objectives for site management are research. Areas are divided into zones of manipulation and undisturbed control areas. Vehicle access to the area can be regulated, but the area is open to regulated hunting and fishing in season. The core area consists of Coweeta and Dryman Fork basins. Both basins have a buffer zone administered by the USDA Forest Service. Forests that have been relatively undisturbed since 1917 occupy about 1,600ha, while management of other areas include plantations (32ha), early successional hardwood stands resulting from clear-cutting at different elevations (134ha), a watershed of multiple use (144ha), strip and selection cuts (187ha), and other manmade clearings (100ha). No recreation or tourist sites are located within the core area, but the heavily used Appalachian Trail follows about 6km of the upper watershed boundary. Timber is harvested by the USDA Forest Service on lands adjacent to the experimental basin.

MANAGEMENT CONSTRAINTS Homes are located along Coweeta Creek in the valley leading to the experimental station. Precipitation chemistry is affected by local agricultural activities and by regional atmospheric processes. Heavy infestations of two defoliators, snow-white eugonia Ennos subsignarius and fall cankerworm Alsophila pometaria have been observed as well as small outbreaks of pine beetle Dendroctonus frontalis.

STAFF Permanent staff include 3 technical, 4 support, 1 Forest Service

BUDGET No information

LOCAL ADDRESSES Coweeta Hydrologic Laboratory, 999 Coweeta Lab Road, Otto, NC 28763

## REFERENCES

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- Gaskin, J.W., Douglass, J.E. and Swank, W.T. (eds.) (1984). Annotated bibliography of publications on watershed management and ecological studies at Coweeta Hydrologic Laboratory, 1934-1984. USDA For. Serv. Gen. Tech. Rep. SE-30. Southeast. For. Exp. Stn., Asheville, NC.
- Swank, W.T. and Crossley, D.A. (eds.) (1987). Forest ecology and hydrology at Coweeta. Springer-Verlag, New York.

## **Southern Appalachian Biosphere Reserve: Great Smoky Mountains National Park Unit**

### IUCN MANAGEMENT CATEGORY

- II (National Park)
- IX (Biosphere Reserve)
- X (World Heritage Site)

BIOGEOGRAPHICAL PROVINCE 1.05.05 (Eastern Forest)

GEOGRAPHICAL LOCATION At the southern end of the Appalachian mountains in eastern Tennessee and western North Carolina, bounded by the Little Tennessee River in the south, French Broad River to the north and Pigeon River in the east. Surrounded by parts of several national forests, an Indian reservation, and a Tennessee Valley Authority lake. Gatlinburg (Tennessee) lies close to the north entrance and Cherokee (North Carolina) the south entrance. 35°26'-47'N, 83°45'-84°00'W

DATE AND HISTORY OF ESTABLISHMENT Designated in 22 May 1926 as a national park (44 Stat. 616) and June 1976 as a biosphere reserve, the park was subsequently redesignated as a unit of the Southern Appalachian Biosphere Reserve in 1988 and listed as a World Heritage site in 1983.

AREA The biosphere reserve covers 209,000ha. The park comprises about 25% of the total area protected in the Eastern Forest biogeographic province.

LAND TENURE Federal government

ALTITUDE 259m-2,025m

PHYSICAL FEATURES The dominant topographic feature of the park is the Great Smoky Mountains massif with 16 peaks over 1,818m. Lesser ridges form radiating spurs from the central backbone. The majority of the topography of the park consists of moderately sharp-crested, steep-sided ridges separated by deep V-shaped valleys. Many of the mountain ridges branch and subdivide, created by a complex of drainage systems with many fast-flowing clear mountain streams. The park contains 22 major watersheds and the water-table is near the surface in most areas. Precambrian metamorphic rocks including gneisses and schists and Precambrian sedimentary rocks of the OCOEE series are predominant, while sedimentary rocks predominate in the Appalachian Valley.

CLIMATE Summers are warm and humid, and winters relatively mild. Mean annual temperature for Gatlinburg is 13.7°C, but average temperatures within the reserve are 5°-10°C cooler, decreasing considerably with altitude. Precipitation averages 1625mm annually, but increases with altitude, differences in average annual precipitation of more than 600mm being recorded between a peak and valley only 15km apart. Snow accumulations may reach 1.2m at 1,500m but are negligible below 1,000m.

**VEGETATION** The area is a Pleistocene refuge and thus an outstanding example of the diverse Arcto-Tertiary geoflora era, having a high number of temperate species, 1,400 species of flowering plants and 2,200 others including 130 trees. Some 30% of the park is virgin forest and areas previously logged have been regrowing for varied lengths of time, presenting a range of successional stages. Deciduous broad-leaved and needle-leaved evergreen conifer forests predominate with smaller areas of treeless grass and heath balds, open wet meadows and cliffs. The vegetation varies continuously with elevation, slope aspect and soil moisture patterns. Notable communities include cove hardwood and hemlock forests dominated by 25-30 diverse tree species such as Liriodendron tulipifera, Halesia carolina ssp. monticola, Tilia heterophylla, Quercus rubra, Fraxinus americana, Acer saccharum, Betula lutea, and Tsuga canadensis. Between six and twelve tree species are co-dominant at any one site, with a diverse herbaceous understorey. A one-tenth hectare plot may support 40-50 plant species throughout the year. Forest areas include northern hardwood forest Fagus grandifolia, B. lutea, Acer saccharum, Aesculus octandra; spruce-fir forest of Picea rubens, Abies fraseri, B. lutea, Sorbus americana; mixed oak forest of Quercus alba, Q. rubra, Q. prinus and Castanea dentata; and pine-oak forest of Pinus rigida, P. pungens, P. virginiana, Quercus coccinea, Nyssa sylvatica and Oxydendrum arboreum. On mesic sites, cove forests grades with elevation into northern hardwoods and finally spruce-fir forest, the transition occurring at ca. 1,700m. At mid and lower elevations, cove forest is replaced by mixed oak and then by pine-oak. Heath balds represent the xeric extreme at higher elevations. Evergreen broadleaved shrubs dominate the heath, including Rhododendron minus, R. catawbiense, Kalmia latifolia and Leiophyllum buxifolium. Grass balds, cliffs, landslide scars and upper elevation forests support the growth of rare southern Appalachian endemics including smoky manna grass Glyceria nubigena, Cain's reedgrass Calamagrostis cainii, and Rugel's ragwort Cacalia rugelii. The entire range of each of the three species is within the park's boundary. These three species and twelve other vascular plants are under study by the US Fish & Wildlife Service for listing as threatened species, and approximately 100 other species are recognised as rare, threatened, or endangered by the two states in which the park is found. In addition, many plants with northern affinities reach their southernmost range limit in Great Smoky Mountains National Park.

**FAUNA** The fauna is diverse including at least 50 native mammals, reflecting the richness of the flora. With the exception of black bear Ursus americanus and white-tailed deer Odocoileus virginianus, large mammals are seldom seen although red fox Vulpes fulva, gray fox Urocyon cinereoargenteus, racoon Procyon lotor, opossum Didelphis marsupialis, woodchuck Marmota monax and bobcat Lynx rufus range throughout the park. Other mammals include red squirrel Tamiasciurus hudsonicus, grey squirrel Sciurus carolinensis, muskrat Ondatra zibethicus, cottontail rabbit Sylvilagus floridanus, several species of mice, moles and shrews, long-tailed weasel Mustela frenata, mink M. vison, and skunks. Several species of bats inhabit the park. The threatened Indiana bat Myotis sodalis (V) is known to use at least one of the park's caves as a winter roost. There have been several recent, but unconfirmed, sightings of mountain lion Felis concolor. Beaver Castor canadensis, apparently once common here, are reappearing in several valleys. Bison Bison bison, wapiti Cervus elaphus, timber wolf Canis lupus (V), fisher Martes pennanti and otter Lutra canadensis once occurred here and could possibly be reintroduced.

Over 200 species of birds have been observed with over 60 permanent residents including robin Turdus migratorius, cardinal Cardinalis cardinalis, song sparrow Melospiza melodia and wild turkey Meleagris gallopavo, and some 100 species have been observed in the park and immediate vicinity during the winter. Peregrine

falcon Falco peregrinus (V) once nested, but this species is rarely seen here now; red-cockaded woodpecker Picoides borealis (V) has also been observed nesting, but the population is sparse and the species seldom seen. Reptile species include seven turtle, eight lizard and 23 snakes. Heavy precipitation and numerous streams make the mountains ideal for a wide variety of amphibian species including about 27 salamanders (red-cheeked salamander Plethodon jordani appears to be endemic to the park), two toads and at least ten frogs. Over 70 species of native fish inhabit the streams including eastern brook trout Salvelinus fontinalis (the park's population may be a separate and threatened subspecies). Other threatened fish species reported include smoky madtom Noturus baileyi, yellow-fin madtom N. flavipinnis (V) and stonecat N. flavus, though some of these may no longer exist in park waters. Over 20 minnow species and several kinds of darter, sucker, sunfish, bass, bullhead and catfish are also found. The park also contains a diversity of invertebrates, especially land snails, spiders, insects and other arthropods, that is not well known. The 105 species of stonefly include endemics such as Magaloptera williamsi, Hansonoterla appalachia, several Capnia spp. and Acroneura lycorias (found only in Sevier County). Most groups reveal a complex assortment of forms that often include species endemic to the park and/or new to science.

CULTURAL HERITAGE Evidence from archaeological sites supports the theory that prehistoric people were hunters and gatherers in the area 15,000 years ago. Present historical and cultural interpretation in the park is based mainly on structures dating from the mid-1800s to 1920 including the finest collection of log buildings in the USA and five historic districts. The National Register of Historic Places includes three historic districts, eight structures and 28 buildings.

LOCAL HUMAN POPULATION No inhabitants live within the protected area although Cades Cove supports a cattle ranch. Subsistence farming and commercial logging have been practised in the past. Some of the 1,200 structures in the park when it was established have been removed, destroyed or allowed to deteriorate.

VISITORS AND VISITOR FACILITIES The park attracts about 680,000 visitors each year. Camping grounds, trailer parks, hotels and other infrastructure are now encouraged outside the park. Facilities within the park include nine campgrounds, two visitor centres and 18 shelters along the Appalachian Trail and other back country trails, totalling 668km. There are several road systems passing through the park as well as over 1,280km of horse and foot trails which dissect the high country.

SCIENTIFIC RESEARCH AND FACILITIES Research funded by the NPS is mainly directed at monitoring impacts and developing methods for reducing, eliminating or compensating for them. Much effort is being made to conduct and coordinate research under the guidance of scientists based at the Uplands Field Research Laboratory. Research projects include the dynamics of exotic wild boar population; influence of certain exotic plants; the influence of balsam woolly aphid; the impacts of hiking, horseback riding and camping on park ecosystems; the dynamics of the park's native brook trout populations as it relates to human activities, and the effects of two exotic species of trout. The laboratory maintains comprehensive monitoring programmes on a variety of chemical pollutants and biological communities. Uplands Field Research Laboratory offers both research and accommodation facilities. The park library and Uplands Laboratory have numerous reference documents, and there are about 600 publications relating to the park. A full bibliography of scientific work has been published (US MAB, 1982a) as well as a history of scientific study in the area (US MAB, 1982b).



CONSERVATION VALUE This section includes a wide variety of species typical of the Southern Appalachians and includes a considerable range of altitudes and vegetation types. It is a Pleistocene refugium and has many examples of the diverse Arcto-Tertiary geoflora, with a high number of temperate species. Some 30% of the park is virgin forest and areas previously logged have been regrowing for varied lengths of time, presenting a range of successional stages. Deciduous broad-leaved and needle-leaved evergreen conifer forests predominate. The reserve is also of cultural interest, including a large collection of log buildings.

CONSERVATION MANAGEMENT A small area is devoted to visitor, maintenance and administrative facilities and the park also contains the historic district of Cades Cove. The remaining area has been allowed to revert to a forest state through natural plant succession and much management effort is directed at keeping human impact to a minimum. The park has an overall management plan and a series of sectoral management plans. Management is under the jurisdiction of the US National Park Service. The management plan divides the park into three main zones: a natural zone 92%; historic zone 1% and development zone 7%.

MANAGEMENT CONSTRAINTS Exotic species of plant and animal, in particular wild boar Sus scrofa and two trout species, are a problem and are removed regularly. Other threats include plant pests such as balsam woolly adelgid, Chinese chestnut blight, air pollution and visitor impact.

STAFF 105 permanent and 200 temporary and full-time employees

BUDGET US\$5,613,000 in the financial statement for 1982

LOCAL ADDRESSES Superintendent, Great Smoky Mountains National Park, Gatlinburg, Tennessee 37738

#### REFERENCES

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U.S. MAB, (1982b). Great Smoky Mountains Biosphere Reserve: History of Scientific Study. U.S.MAB Report No. 5, Washington, DC.

#### Southern Appalachian Biosphere Reserve Oak Ridge National Environmental Research Park Unit

<u>IUCN MANAGEMENT CATEGORY</u>	I (Scientific Reserve)
	IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 1.05.05 (Eastern Forest)

GEOGRAPHICAL LOCATION Located at Oak Ridge, Tennessee on the US Department of Energy's Oak Ridge Reservation west of Knoxville. The city of Oak Ridge borders the site to the north. The Tennessee Valley Authority's Melton Hill and Watts Bar reservoirs on Lynch River form the southern, eastern and western boundaries. The Cumberland Mountains are about 16km north-west and 113km to the south-east are the



Great Smoky Mountains. Oak Ridge NERP represents approximately one third of the Oak Ridge reservation. The three major facilities, Oak Ridge National Laboratory, Oak Ridge Y-12 Plant, Oak Ridge Gaseous Diffusion Plant and their buffer areas are not part of the designated NERP. In Roane and Anderson counties, state of Tennessee. Approximately 35°55'N, 84°17'W

DATE AND HISTORY OF ESTABLISHMENT Established as a distinct unit of Southern Appalachian Biosphere Reserve in 1988. There are designated state natural areas, wildlife management areas and Oak Ridge National Laboratory user facilities.

AREA 5,010ha (core area 950ha, buffer zone 4,060ha). The transition area (9,400ha) is in the Department of Energy Oak Ridge Reservation not within the biosphere reserve.

LAND TENURE Principally federal owned

ALTITUDE 226-413m

PHYSICAL FEATURES The NERP is within the Ridge and Valley province of the Southern Appalachians and is characterised by parallel south-west to north-east oriented ridges of sandstones, shales and dolomite, separated by valleys underlain by less resistant limestones and shale. Topography of the area is characterised by differential erosion of severely folded and faulted rocks ranging in age from early Cambrian to early Mississippian.

CLIMATE Relatively mild, humid summers and cool winters. Rainfall is fairly evenly distributed throughout the year. There is a marked altitude gradient associated with climatic characteristics. Maximum average temperature of the warmest month is 30°C and the minimum average temperature of the coldest month - 1.8°C. Mean annual precipitation is 1383mm at an altitude of 268m (US MAB Committee, 1988).

VEGETATION The vegetation is dominated by vast tracts of forest. The dominant community consists of oak-hickory woodland of Quercus spp., hickory Carya spp., pine Pinus spp., yellow poplar Liriodendron tulipifera, maple Acer spp, and elm Ulmus spp., with willow Salix spp., sycamore Platanus occidentalis and box elder Acer negundo on bottomlands. There are also stands of pine and pine/broadleaf mixed forest of shortleaf pine Pinus echinata and Virginia pine P. virginiana. Large stands of loblolly pine Pinus taeda occur in pine plantations. Cedar barrens consist of scattered red cedar Juniperus virginiana and pine, with a ground cover of Andropogon spp., Liatris spp., Solidaga spp., Linum spp., Echinacea spp., Delphinium exaltatum, Aster spp., Rudbeckia and Agave spp.

FAUNA Common woodland species include white-tailed deer Odocoileus virginianus, gray squirrel Sciurus carolinensis, raccoon Procyon lotor, woodchuck Marmota monax, ruffed grouse Bonasa umbellus and wild turkey Meleagris gallopavo.

CULTURAL HERITAGE Information regarding archaeological sites is given in the Resource Management Plan (Chance, 1986).

LOCAL HUMAN POPULATION There are no inhabitants in the core area or buffer zone. Located adjacent to Oak Ridge city, parts of the area may be acquired for residential and industrial purposes.

VISITORS AND VISITOR FACILITIES Approximately 6,000-7,000 visitors per year (1988). There is an ecological and physical sciences study centre for pre-college

students and public presentations.

SCIENTIFIC RESEARCH AND FACILITIES A wide range of research topics are being undertaken at the reserve unit. Ongoing projects include those on general ecological data management systems, satellite imagery, vegetation surveys, hydrological data collecting and limnological surveys, atmospheric and climatological data gathering and inventories of mammals, invertebrates and vascular plants (US MAB Committee, 1988). Work at Oak Ridge includes studies on development of an Energy Program plan, resource management, tourism and education.

CONSERVATION VALUE This section includes vast tracts of woodland, the dominant community consisting of oak-hickory woodland but with many other tree species typical of the ridge and valley topography. A varied woodland fauna occurs. A number of archaeological sites are included in the reserve.

CONSERVATION MANAGEMENT Permitted activities include fishing, forestry and hay production, hunting and/or trapping and low-key tourist development. The Resource Management Plan for Oak Ridge Reservation includes resource information and site analysis for planning. There is information on aquatic habitats, archaeological sites, rare plants and animals, forestry, geography, demography, topography, soils, geology, laws and waste management. Biosphere reserve functions are to be coordinated with the Environmental Sciences Division and the Department of Energy through Oak Ridge NERP. There are designated state natural areas which are managed under agreement between Department of Energy and State Department of Conservation to protect unique habitats and special plant communities; wildlife management areas are managed under State Wildlife Resources Agency agreement with the Department of Energy with an area manager on site; Oak Ridge National Laboratory facilities provide the opportunity for individuals, industries, university students and faculty to undertake research.

MANAGEMENT CONSTRAINTS Adverse effects include possible transfer of federal lands to city lands for residential and industrial development. Hay cropping is carried out. There is some extraction of hardwoods, loblolly, white and shortleaf pine and overfelling of timber resources may occur. Before 1942 the area was partly used as pig pasture.

STAFF 200 (administrative 42; education 4, research 73)

BUDGET \$41,000,000 (1988)

LOCAL ADDRESSES Energy Research And Development Office, Department of Energy, Oak Ridge Operations, PO Box 2001, Oakridge, TN 37831

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## UNITED STATES OF AMERICA

NAME Champlain-Adirondack Biosphere Reserve

IUCN MANAGEMENT CATEGORY V (Protected Landscape)  
IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 1.05.05 (Eastern forest)

GEOGRAPHICAL LOCATION The reserve includes all of the Adirondack massif in the north-eastern part of New York State and also almost all of the contiguous Lake Champlain catchment, including the lake itself, in Vermont. The reserve is bordered on the north by Quebec, to the east and south by the extension of the Lake Champlain watershed and to the west the boundary is the edge of the Adirondack geological massif. The Adirondack portion is 80km north of Albany and 280km north of New York and the reserve is 50km south of Montreal. 43°00'-45°00'N, 73°15'-75°30'W

DATE AND HISTORY OF ESTABLISHMENT The state-owned land in the Adirondack Park was set aside in 1895 as a forest preserve and is constitutionally to be 'forever kept as wild forest lands' with all cutting of timber banned (N.Y. Constitution, Article VII No. 7, 1895). The Adirondack Park Agency Act (NY Executive Law, Article 27, 1971) is considered by many to be the most extensive attempt by any state in the USA to regulate private land use by means of regional land use controls. The general purposes of the Act are (a) to establish a system of comprehensive land use controls that will protect and encourage the wise use of the unique scenic, aesthetic, wildlife, recreational, open-space, ecological and natural resources of the park; (b) to establish and promote the effective administration of land use controls that will protect the interest of New York State, not only because of its enormous state holdings within the park, but also for the preservation and use of resources on the park's non-state lands; and (c) to encourage the park's local governments to undertake comprehensive land use planning on a local scale and to adopt local land use programmes that fit within the regional guidelines of the Act. In Vermont, Green Mountain National Forest lands are the only areas protected by national legislation as they are under USDA Forest Service control.

AREA 3,990,000ha; this includes core areas totalling 960,000ha, a buffer zone of 1,130,000ha and a transition area of 1,900,000ha. The New York State Adirondack Park section covers 2,426,200ha and contains the largest wilderness preserve in the continental United States outside Alaska.

LAND TENURE New York State section: 1,011,750ha (40%) state-owned; 1,416,450ha (60%) privately-owned and devoted principally to forestry, agriculture and open-space recreation. Over the whole biosphere reserve the main tenure is held by state or provincial government but parts are also owned by local governments, private conservation organisations, private individuals or groups and research institutions.

ALTITUDE 29-1,629m

PHYSICAL FEATURES The biosphere reserve includes parts of seven physiographic regions: the Central Highlands, Northwestern Lowlands, Champlain-St Lawrence Lowlands, Taconic Mountains, Vermont Valley, Green Mountains and Vermont Piedmont. In the north-east part of the Adirondacks are the 46 "high peaks", spread over

3,100 sq.km, 42 of which are over 1,200m (including nine alpine summits) the highest being Mt Marcy (1,629m). These mountains are mainly formed of crystalline, metamorphic and Precambrian igneous rocks of the Greenville province of the Canadian Shield which are about 1.2 billion years old. This highland area is composed of several low mountainous ridges separated by northeast-southwest trending valleys. The Adirondacks have a radial pattern of drainage and contain the headwaters and much of the basins of five major rivers: the Hudson, Black, St Lawrence and Mohawk rivers and the Lake Champlain drainage system. The western and southern Adirondacks have a gentle, hilly landscape with many lakes, ponds and streams. The bedrock here is of Palaeozoic sandstones and limestones, parts of which have been eroded and redeposited by glaciers. The soils are generally coarse-textured, derived from glacial till and include acidic spodosols. Outwash soils also occur in this region. Within the New York State section of the park are 2,759 lakes and ponds, many formed through glacial action in the past and more than 2,413km of rivers fed by an estimated 48,270km of brooks and streams. The Vermont section is dominated by the Green Mountains, a complex anticlinal structure of metamorphosed Cambrian and Precambrian rocks, mainly schists. The Lake Champlain Lowland is made up of younger limestones, shales and sandstones. Glacial action has eroded and redeposited this bedrock and the soils at higher elevations are spodic, derived from glacial till. Lowland soils, found in the major river valleys, are generally inceptisols and alfisols derived from fluvial deposits. The Champlain-St Lawrence Lowlands are overlain by lacustrine and marine deposits.

**CLIMATE** Conditions are cool temperate with 100-150 frost free days per year. Rainfall is fairly evenly distributed throughout the year with a summer maximum. Mean annual rainfall over an altitude range of 24-500m is 711-1346mm. At higher elevations and near large water bodies snowfall ranges from 1524-4445mm per annum. Maximum temperatures in the warmest month are 19°C to 29°C and minimum temperatures in the coldest month -9°C to 16°C.

**VEGETATION** The major natural forest types present are spruce-fir and beech-birch-maple associations and thirty tree species are native to the park. The former is found mainly on wet, shallow and infertile soils (spodosols) between about 800m and 1,370m. In such situations the coniferous element can compete successfully with hardwoods. The dominant species are red spruce Picea rubens and balsam fir Abies balsamea, with white birch Betula papyrifera, yellow birch B. lutea, mountain ash Pyrus americana, black spruce Picea mariana, blueberry Vaccinium sp., hobblebush Viburnum alnifolium and serviceberry Amelanchier sp. On moist, well-drained fertile loamy soils which are generally found at lower altitudes up to about 800m, northern hardwood forest occurs, dominated by sugar maple Acer saccharum, American beech Fagus grandifolia and yellow birch Betula lutea. Other common species include red maple Acer rubrum, eastern hemlock Tsuga canadensis, white ash Fraxinus americana, black cherry Prunus serotina, pin cherry P. pensylvanica, basswood Tilia sp., northern oak Quercus sp., white pine Pinus strobus, balsam fir Abies balsamea, American elm Ulmus americana, red spruce Picea rubens, white spruce P. glauca, eastern hop hornbeam Ostrya virginiana, ironwood Carpinus caroliniana, striped maple Acer pensylvanicum, witch-hazel Hamamelis virginiana, hobblebush Viburnum alnifolium and serviceberry Amelanchier sp. A range of species-rich wetland habitats including deposits of peat also occur in association with the large numbers of lakes and streams. There are some important undisturbed cliff ledge communities, tundra and alpine meadows. Sand beach and dune communities are found around the lake shores. Some sugar maple woods are managed and part of the reserve is used for agriculture with a wide variety of field crops, fruit and vegetables.

**FAUNA** There are at least 64 species of mammals, 297 species of birds (including 193 breeding), 35 species of reptiles and amphibians, and 82 species of fish in the New York state section. Mammals which have rare status in New York State include pine marten Martes americana, grey fox Urocyon cinereoargenteus, southern bog lemming Synaptomys cooperi, long-tailed shrew Sorex dispar, water shrew S. palustris and yellownose vole Microtus chrotorrhinus; endangered species include moose Alces alces. The white-tailed deer Odocoileus virginianus, black bear Ursus americanus and fisher Martes pennanti also occur within the reserve. Birds threatened or endangered in New York State include golden eagle Aquila chrysaetos, bald eagle Haliaeetus leucocephalus, peregrine falcon Falco peregrinus, raven Corvus corax and spruce grouse Canachites canadensis. The endangered Indiana bat Myotis sodalis (V) also occurs.

**CULTURAL HERITAGE** No information

**LOCAL HUMAN POPULATION** There are no permanent residents in the core area but 10,000 people live in the buffer zone and 500,000 in the transition zone.

**VISITORS AND VISITOR FACILITIES** There are approximately 11 million tourists per annum. Finance for construction of two natural resource interpretive centres in the New York state section was approved in 1985-86 by the State Legislature. Both facilities will be administered and operated by the Adirondack Park Agency. Each site will be operational by June 1989, with projected annual visitor use in excess of 340,000.

**SCIENTIFIC RESEARCH AND FACILITIES** A vast amount of research of all kinds has been done in this area and compiling a bibliography would be one task for the biosphere directorate.

**CONSERVATION VALUE** The reserve includes all of the Adirondack Mountains with a number of high peaks as well as much of the Champlain catchment. Within these regions are outstanding areas of wilderness and many scenic features, including those typical of a glaciated landscape. There is a diverse flora and fauna, the dominant plant communities being spruce-fir and beech-birch-maple associations and thirty native tree species occur.

**CONSERVATION MANAGEMENT** The states of Vermont and New York both have a well-established planning and regulatory framework and a biosphere reserve office was to be set up within this framework to promote conservation awareness and coordinate research. In Vermont, the Vermont Land Use and Development Plan pursuant to Act 200 and various regional management plans are relevant to the biosphere reserve.

The New York State section of the reserve is covered by the Adirondack Park State Land Master Plan and the Adirondack Park Land Use and Development Plan, the latter being a regional zoning plan dividing all of the non state-owned lands in the park into six land use areas. It describes the compatible uses, overall intensity of development and character of each land use area. A complex, comprehensive permit system for development is administered by the Adirondack Park Agency (APA). Land use areas are as follows: a) Hamlet areas represent existing settlements, growth and service centres, commercial areas and those with concentrated tourist development. b) Moderate Intensity Use areas (max. of 500 principal buildings per sq. mile or an average lot size of 0.53ha) are close to Hamlets where fairly intense future development, primarily residential, is possible because of the relatively deep soils and moderate slopes. c) Low Intensity Use areas (max. of 200 principal buildings per sq. mile or an average lot size of 1.3ha) are easily

accessible, reasonably close to hamlets, where development potential varies widely but is not constrained by large areas of environmental importance. d) Rural Use areas (max. of 75 principal buildings per sq. mile or an average lot size of 3.44ha) are those where natural resource limitations, shallow soils, relatively severe slopes, critical wildlife habitats, proximity to scenic vistas or public lands and distance from service areas require fairly strict limits on development. These areas are very important to the open space character of the park. Rural Use limitations are designed to prevent strip development along major travel corridors by placing residential development on relatively large lots or clustered on carefully selected and well-designed sites. e) Resource Management areas (max. of 15 principal buildings per sq. mile or an average lot size of 17.3ha) are those where natural conditions place severe limits on development. These areas are important primarily for forestry and agriculture, and their preservation for these activities is essential to the economy of the park. These areas are also vital for recreation and the preservation of the open space character of the park. Approximately 68% of the private land in the park has been classified Resource Management. Industrial Use areas are those where industry or mining operations existed when the APA Act was adopted or where new industry should be encouraged to locate.

With regard to state lands in the park, 15 tracts of Adirondack Forest Preserve are designated Wilderness (approx. 404,700ha). Buildings and access by motorised equipment are prohibited. The largest single category of land (approx. 526,110ha) is Wild Forest, where a variety of outdoor recreational activities are allowed, including the use of motorised vehicles in designated places. Other categories of State lands include: Primitive and Canoe areas, managed similarly to Wilderness areas; Intensive Use areas, such as public campsites, developed beaches and boat launching sites; and State Historic sites. The APA is responsible for developing and updating the Adirondack Park State Land Master Plan which establishes the policy for the management of the State-owned lands. This Master Plan was first adopted in 1972. The actual management of the State lands is carried out by the New York State Department of Environmental Conservation. The APA also has authority to regulate fertiliser use, shoreline cutting and drawdown from lakes. Different local authorities have also set restrictions on the use of snowmobiles and motorboats and water skiing facilities and may regulate sanitary and septic systems. It also issues permits for tree felling within privately-owned forested areas and regulates conditions under which felling is allowed.

There are approximately 378,800ha of wetlands in the the New York State section of the park which are covered by the Freshwater Wetlands Act (NY Environmental Conservation Law, Article 24, 1975) and a statewide wetlands protection statute administered by the APA within the park. APA permits are required for virtually all activities in a wetland and for many activities that may affect a wetland. Regulated activities include any form of pollution, pesticide use, or any draining, dredging or filling of a wetland, or any other activities which substantially impair its functions or benefits. As part of this legislation, the NY State Department of Environmental Conservation, in consultation with the APA, is required to produce official maps of all jurisdictional wetlands in the park. About one fifth of this task is completed.

The Wild, Scenic and Recreational Rivers System Act (NY Environmental Conservation Law, Article 15, 1972) is a statewide statute for the protection of certain pristine rivers, also administered by the APA for rivers flowing through private lands in the New York State section of the park, which contains ninety-five percent of the pristine river mileage in this state. Currently there are approximately 1,930km of designated rivers in the park, with approximately 144km

still under study for possible legislative designation as part of the System. Special permit regulations administered by the APA apply to new land use, subdivisions and most projects within the corridors of designated wild, scenic or recreational rivers. This corridor is generally 1/4 mile either side of a river. Restricted activities for each designated river corridor are keyed to the land use classifications of the APA Act.

MANAGEMENT CONSTRAINTS Increased recreational use and, in particular, unauthorised use of snowmobiles and all-terrain vehicles are a threat in the core areas. Air pollution including acid deposition also affects these areas. Pesticides and fertilisers are used in the agricultural sections of the reserve.

STAFF There are at least 1,100 staff in the whole of the biosphere reserve. Of these, 600 are involved in administration, control and resource management and 65% are university trained. This total also includes 250 people involved in education and training. The Adirondack Park Agency is staffed with 45 full-time employees (including attorneys, planners, engineers, ecologists and cartographers) and 4 to 8 part-time or seasonal workers. It also operates a satellite office in Lake George Basin. The Park Agency is an 11-member body including the Commissioner of the Department of the Environmental Conservation, the Secretary of State and the Commissioner of the Department of Commerce.

BUDGET US\$32 million. In 1987, the Adirondack Park section received about US\$2,200,000 plus \$150,000-200,000 annually in local planning assistance to distribute among those local governments undertaking various planning initiatives. The two interpretive centres in the Adirondack section cost US\$5.7 million and their annual operating costs are estimated at US\$850,000.

LOCAL ADDRESSES The reserve is administered jointly by authorities in the two states. New York: NYS Adirondack Park Agency, P O Box 99, Ray Brook, New York 12977. Vermont: Agency of Natural Resources, Planning Division, Waterbury, Vermont 05676

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## UNITED STATES OF AMERICA

NAME Mammoth Cave Area Biosphere Reserve

IUCN MANAGEMENT CATEGORY II (National Park)  
IX (Biosphere Reserve)  
X (World Heritage Site: Criteria i, ii, iii, iv)

BIOGEOGRAPHICAL PROVINCE 1.05.05 (Eastern Forest)

GEOGRAPHICAL LOCATION Situated in Barren, Edmonson and Hart counties, South Central Kentucky near Park City, which lies within the transition area. 37°07'-37°17'N, 86°00'-86°17'W

DATE AND HISTORY OF ESTABLISHMENT The area was declared a national park on 1 July 1941, under enabling legislation of US Congress (44 Statute 635) of 25 May 1926. Kentucky ceded exclusive jurisdiction over park lands by an act of legislature approved on 22 March 1930 and this was accepted by the Secretary of the Interior on 1 May 1944 by authority of the act of 5 June 1942 (56 Statute 317). Exclusive jurisdiction over the remainder of the land was accepted on 1 May 1965. Certain roads through the park are legally open to the public under Deed No.262 of 18 June 1945. Part of the area is endorsed by the Barren River Area Development District resolution of 24 October 1988. Big Woods Old-growth Forest is designated a state natural area by the state of Kentucky. Green River is designated a wild and scenic river and Green River and Mammoth Cave subsurface streams are designated outstanding resource waters by this state. Accepted as a World Heritage site in 1981 and as a biosphere reserve in 1990.

AREA National park 21,191ha; the area included in the biosphere reserve is 21,217ha, comprising a core area of 20,917ha and buffer zones of 300ha; an additional transition zone covers 62,160ha.

LAND TENURE The national park (core area) is federally owned

ALTITUDE 180-231m

PHYSICAL FEATURES The park is situated in an area known as the Mammoth Cave Plateau and contains an internationally important karst area. The core area is a dissected plateau known as the Chester Upland, formed of sandstone-capped ridges separated by karstified valleys containing sinkholes. It also contains the longest cave system in the world, with known passages extending for over 532km. Most types of limestone cave formation are found here, including long passages with huge chambers, vertical shafts, stalagmites, stalactites and gypsum 'flowers' and 'needles'. On the surface there is a superb karst topography with largely subsurface drainage, sinkholes, cracks, fissures and springs. Groundwater flows from the extensive recharge areas on the plateaux to the southwest through the park's cave system to springs that discharge into the Green River. The erosion by the Green River and its tributaries which formed this system began over 25 million years ago and these rivers are now meandering and deeply incised. The limestone rocks of Upper Mississippian age are highly soluble and include contain fossils throughout, including brachiopods, crinoids and corals. The main series in which the cave systems and karst landscape have developed are the St Louis, St Genevieve and Paoli limestones of the Meramecian. The Chester Upland is capped by sandstones of the Upper Mississippian-Lower Pennsylvania periods. Structural dip in the north-west is about 5m/km. The major soil types are those developed



from limestone residuum and are either alfisols or ultisols. To the east, south and west of the park (included in the transition zone) is the Pennyroyal Plateau which is separated from the Chester Upland by an escarpment.

**CLIMATE** Conditions are humid temperate. Mean annual precipitation is 1118mm at an altitude of 205m and practically all of it is in the form of rain as temperatures are generally above freezing during the day. Mean annual temperature is 13.6°C with a summer mean of 26.6°C and a winter mean of 1.7°C.

**VEGETATION** There is a luxuriant surface vegetation, including 84 tree species, 28 shrubs and vines, 29 species of fern, 209 flower species, 67 species of algae, 27 species of fungi and seven species of mosses. An inventory of the flora is included in the biosphere reserve nomination. Big Woods is reputed to be one of the largest and best remaining examples of the ancient forest of eastern North America that once covered Kentucky. This is temperate deciduous oak-hickory forest dominated by oaks including Quercus alba, Q. velutina, Q. prinus and hickories including Carya glabra and C. tomentosa with some beech Fagus sp., maples Acer spp. polpar Liriodendron sp., ash Fraxinus sp. and cedar Juniperus virginiana.

**FAUNA** Over 200 species are indigenous to the cave system. On the surface are 41 species of mammals, 203 species of birds, 18 species of reptiles and 15 species of amphibians. A faunal list is included in the biosphere reserve nomination. The age of the geological formations has contributed to species richness in the cave fauna, the cave system being old enough to have communities from three karst regions and covering an area large enough for speciation to have occurred. Nowhere else do blind fish Amblyopsis spelaea (V), Typhlichthus subterraneus and their spring cave-dwelling relative Chologaster agassizi co-exist. Resident animal species listed as federally endangered include freshwater mussels Obovaria retusa (I), Hemistena lata (E), Pleurobema plenum (E) and Lampsilis orbiculata (E), Indiana bat Myotis sodalis (V), grey bat M. grisescens and Kentucky cave shrimp Plaesmonias ganteri. There have been successful reintroductions of wild turkey, beaver and deer.

**CULTURAL HERITAGE** The park contains evidence of four pre-Columbian Indian cultures: Mississippian, Woodland, Archaic and Paleo-Indian. The early Woodland culture period is of special archaeological importance because it shows the first evidence of organised horticulture in North America, with primitive agriculture on river floodplains. These Indians used the caves for shelters and chipped gypsum and mirabilite off the walls; more than 150 archaeological sites have been identified within the national park. Saltpetre deposits were discovered on the cave walls and this valuable nitrate was removed and sent to be processed in gunpowder factories between 1809 and 1819. After the 1812-1815 war Mammoth Cave became a national and international tourist attraction. Three churches and fourteen cemeteries still exist in the park and are used by the public.

**LOCAL HUMAN POPULATION** There are no permanent inhabitants in the core area. About 240 people live in the buffer zones with a further 1500 in the transition area, including about 600 in Park City. Population density in the region surrounding the park is low (30 per sq.km) and has remained stable for the past 20 years. Only 25% of the population is considered urban and no significant increase in urbanisation is expected in the near future. Most people are engaged in agriculture, tourism or service industries.

**VISITORS AND VISITOR FACILITIES** Since a peak in 1979 of 1.6 million visitors, numbers remained stable near this level into the 1980s with an increase occurring in recent years to about 2 million per annum. The summer months of June, July and

August account for over 60% of the annual total. Park headquarters are located at the historic entrance to Mammoth Cave and there is a visitors' centre here, but this is very small. Guided tours are offered of the underground portion of the park and there are commercial boat trips on Green River. There are 155km of roads within the park and many hiking trails including over 45 miles in the remote section of the park but there are only two small ferries across the Green River so that resources in much of the remoter hilly areas of the park remain untapped. Access is good and it is estimated that a third of all visitors do no more than drive through the park. There are about 110 rooms in a hotel, lodge and various cottages and restaurant and shopping facilities in the buffer zone but a further 2,000 motel rooms and over 7,500 campsite places are located within easy distance of the park.

SCIENTIFIC RESEARCH AND FACILITIES Long-term hydrological and ecological research into karst systems is being carried out in the Mammoth Cave area, including the effects of water quality on the cave's biota. In particular, research into groundwater flow-pulse rates and modelling has been applied to the development of instrumentation packages for monitoring the physical and chemical properties of groundwater. Preliminary discussions of the international applications of this have been initiated. Much research into a variety of aspects has already been carried out. A research facility and laboratory are available to visiting researchers. The US Geological Survey plans to further delineate groundwater basins in the area and the Agricultural Stabilisation and Conservation Service will be studying the effects of agriculture on groundwater in the transition zone. There are cooperative agreements with Western Kentucky University, Eastern Kentucky University, the Cave Research Foundation and the American Cave Conservation Association for research and education or training opportunities.

CONSERVATION VALUE The Mammoth Cave area is an internationally important karst area. It contains the longest cave system in the world, with known passages extending for over 532km. Most types of limestone cave formation occur here. Over 200 species of animal are indigenous to the cave system including several endangered species of blind fish, shrimp, bat and freshwater mussel. Surface features are also important and Big Woods, a temperate deciduous oak-hickory dominated forest, is reputed to be one of the largest and best remaining examples of the ancient forest of eastern North America that once covered Kentucky. Archaeological sites in the area show evidence of four pre-Columbian Indian cultures.

CONSERVATION MANAGEMENT The core area (Mammoth Cave National Park) is managed by the National Park Service. The transition zone falls within Barren River Development District of which three counties are within the Mammoth Cave system recharge area. The Biosphere Reserve Cooperative Subcommittee of the Natural Resources Council of the Barren River Area Development District will coordinate biosphere reserve functions. The general management plan for the national park (1983) states that the management aims at Mammoth Cave National Park are to perpetuate the integrity and diversity of geological features and life systems associated with the caves and preserve aquatic and terrestrial environments for their aesthetic, recreational, educational and scientific values. Within the core the management plan identifies separate natural zones and historic zones and it classifies caves into six types according to the access approved. A resource management plan has been compiled (Anon., 1988), which includes natural and cultural resource management programmes. The oak-hickory woods of the national park are being allowed to return to their natural state. Some of the oak and poplar forests are currently managed but there are no plantations. As well as public recreation, authorised fishing and hunting is permitted in the core area.

Narrow corridors along roads within the core zone have been designated as zones of managed use and concentrate tourist developments, administrative and recreational facilities. A transition zone for the biosphere reserve has also been designated to the south and east of the core area to curtail groundwater pollution as this is where much of the rainwater which flows through the cave systems of the park falls. Federal, state and local authorities have cooperated to develop a regional sewer system in this area, surrounding Park City, to stop pollutants reaching the groundwater.

**MANAGEMENT CONSTRAINTS** Damage to irreplaceable cave features occurred during the early periods of cave use, including smoke deposits from torches and fires and graffiti. The use of electric lighting for cave tours has also led to the introduction and growth of mosses, fungi and algae in the caves and may eventually spoil the natural beauty of some of the unique formations. At least 130 cave entrances have been identified as needing some level of monitoring for illegal entry. Several cave gates are in need of repair. Oil and gas wells were also drilled in this area and although those inside the park were abandoned when it was established they still pose a threat to human safety and environmental quality as many have been insufficiently plugged. In adjacent areas, oil and gas exploration has increased recently and with this, the risks of spillages into the park's groundwater system including that of injected dyes. About half of the Mammoth Cave system actually lies outside the national park boundaries but management of these areas should be improved by the designation of a transitional zone to the biosphere reserve. Commercial freshwater mussel fishing outside the park has destroyed the natural mussel beds there and illegal operations have expanded into the park, resulting in conviction of the operators.

A wide variety of arable and animal farming occurs in the transition zone and this area is now increasing its light industry. However, solution of the existing pollution problems should provide a basis for increased opportunities to attract sustainable economic development compatible with the karst terrain. Of major environmental concern is the extensive sinkhole plain to the south and east of the Park. Run-off from this area flows via underground streams into the Green River and includes effluent from Park City. There has also been illegal dumping of wastes into sink holes in the transition zone. Any changes in quality or quantity of water would adversely affect the unique aquatic life in the underground streams and alter natural cave development but this problem is now being addressed (see previous section).

**STAFF** The biosphere reserve has a staff of 94. Of these, 20 are involved in administration, control and resource management within the core area and 17 are university educated. There are 12 staff for education and training purposes and three involved in research who have a technical support of up to ten personnel.

**BUDGET** US\$ 3,500,000 annually

**LOCAL ADDRESSES** Mammoth Cave National Park, Mammoth Cave, Kentucky 42259

#### **REFERENCES**

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NAME Tsentralnosibirskii State Nature Reserve

IUCN MANAGEMENT CATEGORY I (Strict Nature Reserve)  
IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 2.03.03 (West Eurasian Taiga)/2.04.03 (East Siberian Taiga)

GEOGRAPHICAL LOCATION Lies in Krasnoyarsk Territory and extends over two regions: the eastern part of West Siberian Lowland (Zapadno-Sibirskaja Nizmennost) and the western provinces of the Central Siberian Plateau (Sredne-Sibirskoje Ploskogorje). The boundary does not follow any topographical feature in the west, but in the east it curves to include some of the catchment area of Podkamennaya River. 60°55'-63°15'N, 84°15'-92°30'E

DATE AND HISTORY OF ESTABLISHMENT Created a state nature reserve by the Council of Ministers of the Russian Soviet Federated Socialist Republic Decree of 9 January 1985. Accepted as a biosphere reserve in October 1986.

AREA 5,000,000ha. The strict nature reserve of 972,017ha constitutes the core area.

LAND TENURE State. In January 1985, 682,054ha of forest land were removed from the tenure of Nizhne-Eniseikii Forestry Unit and 289,963ha of forest land was removed from the tenure of Turukhanskii Forestry Unit to be managed as the reserve area.

ALTITUDE 80-500m

PHYSICAL FEATURES The reserve is divided from south to north by Yenisey River, with Siberian lowland to its west and higher ground (Siberian Plateau) to its east. The river itself is 2-3km wide, while the valley, which is strongly asymmetrical, is 8-10km wide. The glacial plain in the west is characterised by swamps and slow rivers, while to the east rivers are steep and swift. The basin of Podkamennaya Tunguska River is characterised by precipices, cliffs, rapids and waterfalls (Anon, 1986). The bulk of the reserve is in the permafrost zone; near the south the soils are podzols, brown taiga and alluvial flood-plain (Syroechkovsky, n.d.).

CLIMATE A mean annual temperature of -5.8°C and mean annual precipitation of 500mm has been recorded at an altitude of 150m within the reserve (Anon, 1986). Minimum winter temperature has been recorded at -62°C, maximum summer temperature at 38°C (Syroechkovsky, n.d.).

VEGETATION In view of its wide range of physical features, all taiga ecosystems characteristic of Central Siberia are represented in the reserve. The flora is typical of the middle taiga sub-zone. Pinus sibirica and Larix spp. predominate. Picea spp., Abies spp., Pinus spp., Betula spp. and Populus tremula are also common. Birch and aspen forests comprise about 50% of the core area. The upper parts of the plateau are forest-free and dominated by stony goletz and mountain tundras. There are about 700 species of vascular plants, representing 73 families, in the core area, including some endemic and relict species. 70 plant species are recorded, including Botrychium lunaria, Selaginella selaginoides,

Brachypodium pinnatum, Elymus jennisensis, Lilium pennsylvanicum, Cypripedium macranthum and Oxytropis katangensis, which have been proposed for strict protection (Syroechovsky, n.d.; Anon, 1986).

**FAUNA** The reserve is important for taiga species. There are 40 species of mammals including sable Martes zibellina, elk Alces alces, bear Ursos arctos, badger Meles meles, otter Lutra lutra and lynx Felis lynx. 237 species of birds (including 137 breeding species) are represented, which include the following species listed in the USSR Red Data Book: black stork Ciconia nigra, red-breasted goose Branta ruficollis, lesser white-fronted goose Anser erythropus, Bewick's swan Cygnus columbianus bewickii, osprey Pandion haliaetus, white-tailed sea eagle Haliaeetus albicilla, golden eagle Aquila chrysaetos, gyrfalcon Falco rusticolus, peregrine falcon Falco peregrinus, solitary snipe Gallinago solitaria and Sabine's gull Xema sabini. The reserve also supports two species of reptiles, four of amphibians and 29 species of fish (Syroechovsky, n.d.; Anon, 1986).

**CULTURAL HERITAGE** The harsh climate of Siberia has always limited man's development in the region. While man's impact has been small, there has been a long tradition of hunting and fishing in the area.

**LOCAL HUMAN POPULATION** The core area is totally free from modification by man. Territory to the south of the core area is inhabited by the Kets, whose main occupations are hunting and fishing, while to the north live the Evenks. Their main occupations are hunting and reindeer husbandry. The rest of the reserve is inhabited by Russians, most of whom have lived in the area for generations. Their occupations, besides hunting and fishing, include forestry and agriculture. Such activities are patchily distributed (Syroechovsky, n.d.; Anon, 1986).

**VISITORS AND VISITOR FACILITIES** No information

**SCIENTIFIC RESEARCH AND FACILITIES** Integrated ecological research on soil, vegetation and animal populations has been conducted in the core area since 1969 by the Institute of Evolutionary Animal Morphology and Ecology of the USSR. Detailed inventories of flora, fauna and soil are the first priority in the reserve's research programme. Within the reserve the settlement of Bor provides the main centre for administration and research and it can be reached by air, or by boat during the summer (Syroechovsky, n.d.; Anon, 1986.)

**CONSERVATION VALUE** The reserve is 800-1,000km from the nearest industrial town or city. It contains representatives of all taiga ecosystems for Central Siberia. Its unspoilt nature makes it ideal for species and ecosystems research. Yenisey Valley is one of the major flyways in the Eastern Palaearctic. Some avian species have been listed in the USSR Red Data Book. Seventy species of plant have been proposed for strict protection (Syroechovsky, n.d.; Anon, 1986.)

**CONSERVATION MANAGEMENT** The reserve has a core area of 972,000ha, within which any form of development is totally prohibited; a buffer zone of 150,000ha; a research zone of 120,000ha, which lies alongside the north-west corner of the core zone with Yenisey River flowing through it, and traditional taiga land with an area of about 4,000,000ha. The taiga is used for traditional activities (hunting, fishing, reindeer husbandry) and contains relatively restricted zones for forestry and agriculture. The core area includes 60km of the Yenizey Valley (Syroechovsky, n.d.; Anon, 1986.)

**MANAGEMENT CONSTRAINTS** No information

STAFF 118 staff, including administrative and research workers

BUDGET No information

LOCAL ADDRESSES Tsentralnosibirskii State Nature Reserve, 663196 Bor (Turukhansk, Krasnoyarsk)

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## USSR - Estonia SSR

NAME West Estonian Archipelago Biosphere Reserve

IUCN MANAGEMENT CATEGORY I (Strict Nature Reserve)  
IX (Biosphere Reserve)

BIOGEOGRAPHICAL PROVINCE 2.10.05 (Boreonemoral)

GEOGRAPHICAL LOCATION The biosphere reserve comprises an archipelago in the Baltic Sea, some six nautical miles off the coast to the west of the town of Haapsalu. The archipelago comprises the islands of Abruksa, Hilumaa, Muhu, Ruhnu, Saaremaa and Vormsi, and is within the administrative districts of Kingissepa, Hiiumaa and Haapsalu. The boundary follows the sea borders of these districts seven nautical miles from the coast. 58°30'N, 22°50'E

DATE AND HISTORY OF ESTABLISHMENT The biosphere reserve was created by decision of the Supreme Soviet of the Estonia SSR on 6 December 1988 and by decision of the Council of Ministers of the Estonia SSR on 27 December 1989. The final boundary of the reserve is to be approved by the Council of Ministers of Estonia SSR with the approval of the local authorities.

AREA 403,778ha terrestrial and 1,156,078ha marine. The biosphere reserve includes Vilsandi SNR (10,689ha) and Viidumäe STVR (1,194ha), adjoins Matsula SNR (39,697ha) in the north, and is separated from Slitere SNR (15,037ha) in Latvia SSR by 25km of the Irbenski Strait.

LAND TENURE The land is primarily owned by provincial and local governments, and the core areas (50 in total) are under state protection. There is also land under national government ownership and a total of 43 other land users.

ALTITUDE 0-63m

PHYSICAL FEATURES The islands lie in a region which is still rising following the last ice-age (3mm per year), and the generally flat landscape is broken by steep banks, beach barriers and cliffs. The underlying quaternary sediments (2-7m thick) consist of Ordovician and Silurian limestone plateaux, marl, dolomites and Devonian sandstone. Glacial deposits cover much of the area. The relief is strongly influenced glacial and seashore processes, with the high ground comprising weathered limestone. The oldest islets rose from the sea some 5,000-2,000 years ago and have been moulded by wave action, wind and hummock ice, whilst the cores of several islets consist of formations of end moraines and sedimentary rocks, with a surface cover of sandy gravel, shingle or ryhk-till, and some small swampy lakes. Most of the land area is covered by geologically young soils consisting of thin, weakly-developed horizons, saline sea-shore and shingle on limestone, with remaining areas covered by podzol-type (ryhk) glacial sediments (moraine, varved clay) and sea bottom deposits. Moonsand Strait has a maximum depth of 22m (deepest point 64m), with 49% of the area at less than 5m, and a salinity of 5.9-6.0‰.

CLIMATE Conditions are temperate continental Atlantic, with local Baltic Sea influences. The average temperature is 6°C, with maximum average temperature 19.6°C (the warmest month is July) and minimum average temperature -13.9°C (coldest month is February). The warm period from April runs for 240-250 days, with maximum annual solar radiation of 85 ccals/cm<sup>2</sup> and a vegetation period of 170-

185 days. Snow cover lasts 80-120 days with a depth of 30-40cm in February. Mean annual precipitation is 510mm (at 1.5m). Winds are greater than 15m/sec. on 23-39 days in the year. Seawater temperature varies from 12°C in January to 16°C in June.

**VEGETATION** There are three main vegetation types: on the islands, seashore halophilous meadow, alvars, and broadleaf forest and wooded meadow. Seashore halophilous meadows comprises species such as Eleocharetum parvulae, Triglochin tetralix, Bolboschoenetum maritimi, E. uniglumis, Salicornetum europaeae, Puccinellietum maritima, Speularietum salinae, Glaucomaritimaetum junceum gerardii, Festucetum arundinaceae, Seslerietum caeruleae, Arrhenatheretum elatioris, Carex distachya, Hierochloetum odoratae and Elytrigietum repens. Alvars comprise species such as Juniperus communis, Lonicera xylosteum, Rhamnus cathartica, Ribes alpinum, Rosa spp., Sorbus aucuparia, S. intermedia, Cotoneaster integerrima, Viburnum opulus and associations of Thymus serpyllum, Gallium verum, Ditrichum flexicaule, Filipendula vulgaris, Trifolium montanum, Carex flacca, Sesleria caerulea, Festuca ovina, Thymus serpyllum. Broadleaf forest and wooded meadows comprise species such as Quercus robur, Tilia cordata, Ulmus glabra, Acer platanoides, Fraxinus excelsior, Populus tremula, Ribes alpinum, Lonicera xylosteum, Swida sanguinea, Coryllus avellana, with meadow associations of Scorzonera humilis, Melampyrum nemorosum, Filipendula vulgaris, Sesleria caerulea, Carex pallescens, Scorzonera humilis, and 20 orchid species. Fifty percent of the region is woodland, with some of the best preserved broadleaf forests to be found on the islands of Saaremaa, Hiiumaa, and Aburka. There are also a number of rare species and species that are at the limit of their area of distribution, namely Pinguicula alpina, Juncus obtusiflorus, Hedera helix, Cladium mariscus, Cypripedium calceolus, Gymnadenia conopsea, Taxus baccata, Sorbus rupicola.

**FAUNA** The islands are poorer in animal species compared than the neighbouring mainland. Three areas are set aside specifically for bird conservation, with six species of Estonia SSR Red Data Book status present, namely Anser anser, Cygnus olor, C. cygnus, Pandion haliaetus, Haliaetus albicilla and Grus grus. Other notable species are Parnassius mnemosyne odisseus, Helix pomatia, Bufo calamita, Lacerta agilis, Halichoerus grypus and Myotis dasycneme. Of the fish species recorded, three are of economic interest: Baltic dwarf herring Clupea harengus membras, flatfish Pleuronectes flesus and pike-perch Lucioperca sandra.

**CULTURAL HERITAGE** Remains of ancient settlements, with further traces of Palaeolithic settlements, are found on the hills surrounding the meteorite craters of Kaali. There is a castle at Kuressaare dating back to the Middle Ages.

**LOCAL HUMAN POPULATION** The major settlement within the reserve is Kuressaare (population 15,000) on the southern coast of Saaremaa Island. Land use includes agriculture, fishing and shellfishing and urban development. Of the total population of 51,000 (a decrease of one-third on the pre-war figure), 20% lives permanently within the buffer zone (with 35% in Kuressaare) and 80% in the transition zone. Barley, rye, wheat, oats, potatoes, foraging vegetables and fruit are currently grown. Cows, sheep and horses are grazed predominantly. The commercial forested areas are planted mostly with Scots pine and Norway spruce. Benefits provided to the local population by the biosphere reserve include employment, educational and training opportunities and a range of other benefits including recreation and the maintenance of traditional cultures and resource-use practices.

**VISITORS AND VISITOR FACILITIES** Visitor numbers vary between 180,000 and 250,000



annually, and interpretive programmes are provided. Environmental education is provided for school children and students (graduate and post-graduate).

**SCIENTIFIC RESEARCH AND FACILITIES** It is estimated that some 70 scientists participate in research on site, with a further 15 visiting foreign scientists. Research relates to land use and management issues and is used to support site management and sustainable conservation. Although no permanent monitoring or research programme exists, the site is being considered for development of more long-term monitoring and research activities in association with other national and international programmes. Research material available includes aerial photographs, bibliography, history of scientific study, with assessment data and maps, topographic maps, vegetation and land cover maps, aquatic ecosystems, fresh and marine bathymetric maps, hydrological data on surface and groundwater, as well as limnological surveys, water and air quality and climatological data. Biological inventories exist for fish, mammals, other vertebrates, invertebrates, phytoplankton, macrophytes (aquatic) and non-vascular plants. There is also information on coastal geomorphology and geological and soil maps. Socio-economic and cultural information includes ethnobiological data, land/water use history and land/coastal use maps. The site is well equipped with facilities including an air, climatological and hydrological monitoring stations, laboratories, library, conference facilities, lodgings for 25 visiting scientists, research vehicles and office infrastructure. Ecological data management systems already exists, and it is planned to introduce an automated geographical information system and use of satellite imagery. There are also permanent monitoring plots for marine benthic communities and vegetation.

**CONSERVATION VALUE** Includes eutrophic mires, with Carex hostiana, Juncus subnodulosa and Rhinantuns osiliensis, juniper shrubs and species-rich dry wooded meadows and pine forests.

**CONSERVATION MANAGEMENT** The site is divided into core areas covering 119,000ha and buffer zones covering 357,000ha. There is also a transition zone of 1,084,078ha. Legislation covering the site is state, provincial and local, with administrative regulations and ownership rights also applying. National legislation is secondary. A number of activities take place in the core zone, including authorised hunting and/or trapping. The area includes two state nature reserves and 65 other reserves covering 7,993ha. There are plans to create 20 new reserves. A biosphere reserve board will be established as a state enterprise, with representatives from all districts. The budget will be raised from the state allocation, economic relations and a special fund. The board's activities will be directed by a council delegated from the members of participating organisations, and a scientific council will consist of research associates. There is also an enterprise council. A regional development plan for the reserve will be prepared, together with socio-economic guidelines. Professional training is carried out on site and workshops are organised for reserve managers and planners. It is envisaged that services will be provided for local people and staff training.

**MANAGEMENT CONSTRAINTS** Sea-shore halophilous meadows and alvas are grazed by sheep. Game animals, such as wild boar Sus scrofa, moose Alces alces and roe deer Capreolus capreolus are hunted in the buffer and transitional zones, and some hunting is authorised in the core zone. Destruction of terrestrial habitats, wetlands and natural marine habitats occurs in the buffer zone as well as grazing, forestry exploitation, industrial, mineral and tourist development, shipping and aircraft activities. Human activity is much greater in the transition zone and includes fishing, forestry, gathering of natural products, grazing, hunting and

trapping, industrial and residential development and poaching. Natural ecosystems on several islands have been damaged by human activity and surface and underground water and sea areas, particularly in the bays, are polluted by chemicals and biological substances. On the social side, traditional agricultural practices are disappearing, leading to loss of soil fertility, and accumulation of pesticides and heavy metals.

STAFF Totals 50 including state and local government nature protection and forestry specialists and a further 12 administrative, control and resource management personnel. Five staff are responsible for education and training and 15 for technical support for research.

BUDGET 260,000 roubles, supported 70% by the national nature conservation fund, 5% by local authorities and 25% by government budget.

LOCAL ADDRESSES West Estonian Archipelago Biosphere Reserve, P O Box 209, Kuressaare 203 300, Estonia SSR (Tel: 7(0142)(245)579-75/Tlx: 173816)

#### REFERENCES

Estonian SSR MAB Republican Committee (1990). Biosphere Reserve Nomination Form and review document.









A stylised 'ankh', the ancient Egyptian sign for life has been incorporated into the symbol of the Programme on Man and the Biosphere (MAB)

Une stylisation du 'ankh' signe de la vie dans l'ancienne Egypte, a été introduite dans le sigle du Programme sur l'homme et la biosphère (MAB)